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ABSTRACT

Contents of this teacher's manual for use in an industrial design course are the same as that of the companion student manual except that answers to the objective tests are included. Chapter I describes the emergence of industrial design as a profession and emphasizes specific designers and their contributions to the field. A twenty question objective test is included. Chapter II presents ten principles of well-designed products. Five student activities (creative problem-solving, re-design, and critique exercise) and a twenty question objective test are included. Two industrial design case studies and a twenty question objective test comprise chapter III. Chapter IV describes the design problem-solving process. Problem stating, alternative statements, ideation, brainstorming and the Teague approach are presented. Three student activities are included. Visual communications in the design process are described in chapter V. Topics include sketching, perspective, incorrect proportion, improper conveyance, convergence, visual distortion, drawing shapes, rendering, line drawings, and matting. The use of models is covered in chapter VI including preliminary study models, appearance evaluation models, modelmaking tips, contour drawing, and working drawing. The concluding chapter describes the use of presentations as a means of conveying ideas to others. The student manual is available separately (see note). (JH)

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State of New Jersey
Department of Education
Division of Vocational Education

industrial design in education

teacher's manual

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Glassboro, New Jersey

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C. Samuel Micklus

INDUSTRIAL DESIGN DEFINITIONS

The following definitions of industrial design are offered for reference:

HAROLD VAN DOREN

Industrial design is the practice of analyzing, creating, and developing products for mass manufacture. Its goal is to achieve forms which are assured of acceptance before extensive capital investment has been made and which can be manufactured at a price permitting wide distribution and reasonable profits.

DICTIONARY OF OCCUPATIONAL TITLES

INDUSTRIAL DESIGNER (profess. & Kin.) 142.081

Product designer. Designs form of products to be manufactured and associated packaging and trademarks: sketches design of products, such as furniture, lamps, motor vehicles, radio cabinets, and household appliances, taking into consideration appearance for sales appeal, serviceability in adapting design to function, price, costs, and methods of production, and specifications stipulated by clients. Frequently confers with sales and market analysis personnel to obtain design ideas and to estimate public reaction to new designs. Coordinates drafting of sketches into working drawings and specification sheets for products personnel. May make comprehensive drawings of product, using airbrush. May form models in plaster or clay, or fabricate models in paper, plastic, wood, or metal, using handtools. May be designated according to specialization.

TABLE OF CONTENTS
Teacher's Guide

	Page
Acknowledgements	i
Industrial Design Definitions	ii
CHAPTER I	
Introduction to Chapter I	1
Chapter I – A History of Industrial Design	2
Evaluation	11
Answers to Chapter I Evaluation	14
CHAPTER II	
Introduction to Chapter II	15
Chapter II – Principles of Well-Designed Products	16
Industrial Design Activity (Creative Problem-Solving Activities)	22
Industrial Design Activity (Lighter)	26
Industrial Design Activity (Critique Products)	28
Evaluation	29
Answers to Chapter II Evaluation	38
CHAPTER III	
Introduction to Chapter III	39
Industrial Design Case Studies	40
Evaluation	50
Answers to Chapter II Evaluation	53
CHAPTER IV	
Introduction to Chapter IV, V, and VI	54
The Design Problem-Solving Process	55
Industrial Design Activity (Splash Machine)	58
Industrial Design Activity (Classroom Brainstorming Activity)	60
Industrial Design Activity (Teague Approach)	63

Page

CHAPTER V
Visual Communications 64
Industrial Design Activity (Horizon Lines) 68
Industrial Design Activity (Critiquing Cubes) 71
Industrial Design Activity (Sketching Cube, Cone, and Cylinder) . 74
Industrial Design Activity (Sketching a Block in a 30°–60° Perspective) 77
Industrial Design Activity (Critiquing Ellipses) 80
Industrial Design Activity (Sketch a Rectangular Object With a Hole in One Plane) 84

CHAPTER VI
Models 90

CHAPTER VII
Presentations 97

INTRODUCTION TO CHAPTER I

The illustrations which appear in Chapter I are included in the accompanying slides numbered one through 27.

OBJECTIVES:

1. *The student will be familiar with some of the more significant names in the industrial design profession as indicated by demonstrating the ability to associate specific designers with some of their contributions.*

2. *The student will have a knowledge of some of the major generalizations about the development of the industrial design profession by demonstrating the ability to answer questions relating to the types of professions from which the pioneer designers came and the approximate time the profession began.*

3. *The student will be able to answer specific questions describing the role which the industrial designer plays in product development.*

4. *The student will have a knowledge of words/terms used in the industrial design profession as indicated by demonstrating the ability to identify each with its correct meaning.*

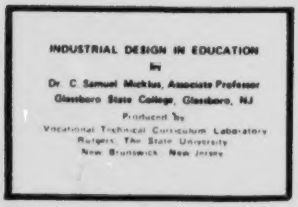


Fig. 1.1

Chapter I

A HISTORY OF INDUSTRIAL DESIGN

We know neither the creators of many milestone inventions nor precisely when they occured. The technological invention of the plow set a completely new era for humanity. It elevated man from a food gatherer to a food producer. One advantage, which the producer has over the gatherer, is that she/he can plan for future growth and ensure having a surplus. This surplus released time and energy to other things, which over the ages led to cities and civilization.

Fig. 1.2

Throughout the ages humans have expressed themselves through artisitc and technological creations. Cave paintings and the designs carved on early relics, such as tools and weapons, show signs of the human need for creative expression. Perhaps this also indicates an inate need to combine art with technology. Technology began the time a human first hurled a rock as an extension of the power of the arm.

LEONARDO DI VINCI

Leonardo di Vinci exemplifies the human inventive capacity more than anyone in recorded history. This 15th century genius investigated numerous areas of art and sciences and recorded his observations in thousands of notes and drawings.

Fig. 1.3

He was the ideal, or the comprehensive man. He became famous as a painter and a sculptor by his early twenties. He was an accomplished musician, a powerful athlete, a brilliant scientist, an engineer, and an inventor.

Fig. 1.4

Many of his inventions were designed to solve existing problems of his day. For instance, he often made maps for military purposes and for canal construction. To make maps more accurate, he designed several distance recording devices such as the odometer. This was geared to drop a pellet into a container for a given number of revolutions of the wheel. The number of pellets would then be used to determine the distance traveled.

Fig. 1.5

Among his many inventions were devices to lift weights, reduce friction, and to test materials in order to use them more effectively and economically. In addition to solving practical problems, Leonardo envisioned future developments such as flying machines, automobiles, and automation. Many of his schemes for flying machines were based on a flapping wing. *Leonardo di Vinci may be described as the industrial design prototype.* He combined art with engineering and worked on a wide scope of undertakings. Centuries later industrial designers would undertake challenges to provide aesthetic expression to a vastly wide range of products ranging from ash trays to spaceships.

Fig. 1.6

With the industrial revolution came inventions by many individuals, which gave rise to new machinery, new skills, and new industries. This was the era of expansion and growth of the railroads; however, it was not a very satisfactory era for design. Buildings, machinery, and home furnishings met a basic functional level; then natural motifs such as fruit and flowers were used as absurd ornaments to decorate them.

THE BAUHAUS

Fig. 1.7

In Germany, *Walter Gropius founded the Bauhaus in 1919.* The Bauhaus, or when translated, the "building house," was an art university which *brought together a faculty of more distinguished artists than any other art school.* This ancestor to the industrial design profession embarked against the lack of sophistication in the design of products. The term "industrial design" did not exist

at this time, nor did the profession crystallize until *the Bauhaus faced the problem of good design in mass production. It established that the artist was needed in addition to the engineer in mass production. Tools and machines became legitimate tools of the artists and designers* in order to give products a maximum of function and efficiency. It professed to create forms which symbolized the machine age.

Fig. 1.8

The Bauhaus developed a new modern kind of beauty. Its influence spread throughout the world and was especially strong in the United States and England. The rise of Nazism in Germany forced its closing in 1933. Many of its prominent faculty emigrated to the United States.

FACTORS HELPING THE INDUSTRIAL DESIGN PROFESSION TO EMERGE

1. Products were decorated

In the latter part of the 1920's, most products manufactured in America were concerned only with function. Any consideration for appearance was in the form of decoration added to the product. Women were the chief spenders of money and had more leisure and money at their command than ever before. Products were decorated and shaped to appeal to them. Little thought was given to the user, attractiveness, or the efficient use of the products.

2. High Competition

Products soon became more and more competitive as the market became saturated.

3. Appearance became a sales factor

Perhaps the public, not having strong traditional ties in terms of design and usually receptive to the new and different, was yearning for a change. *The industrial designer emerged as appearance became a new method of merchandising and product appearance became a sales factor.* These people who would become the avant-garde of the new industrial design movement worked in fields such as architecture, commercial art, stage design, and fashion illustration.

The period from 1927 through the early 1930's marked the beginning of the industrial design profession. *The depression provided industry with an incentive toward design.* Competition was still existent because consumer pruchasing power was very low.

THE PIONEER DESIGNERS

The first designers may be called "pioneer industrial designers." They acted primarily in the capacity of independent consultants to manufacturers. *They were called upon mainly to beautify products in order to stimulate sagging sales* resulting from overproduction and the depression.

It should be noted that a product is seldom designed by an individual. Most design consultants have a staff, and they collaborate with individuals in the client's management.

Norman Bel Geddes

Fig. 1.9

Norman Bel Geddes was a successful advertising art director, portrait painter, and theatrical designer.

In *1927 Geddes opened the first industrial design* office. He is credited with having contributed the word "streamline" into our everyday vocabulary by making streamline an appearance value and a symbol of machine age style.

He was the author of the book, *Horizons.* An extremely original artist with far-sighted engineering vision, he made working drawings for a 600-passenger airline, a streamlined train, and rear-engined automobiles.

Some designers believe that Geddes was the "most powerful" of the industrial designers in terms of vision and creativity, and that he served as an inspiration to many others.

Walter Dorwin Teague

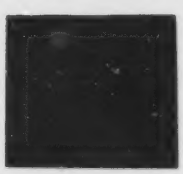


Fig. 1.10

Walter Dorwin Teague had a reputation for several commercial successes. *He achieved prominence as an advertising artist and an authority on typographic design.* Teague came into the fold of industrial design almost immediately after Norman Bel Geddes; he became one of the world's foremost designers. His first major client was the Eastman Kodak Company in 1927. In the formative years of industrial design, methodology had yet to be devised. As time went on, certain methods were developed for solving design problems. Teague would study the operating, structural, and production requirements, as well as the marketing problems, including the products of the competitors. When designing a product, he would use methods ranging from preliminary sketches to completed models. These were also offered to assist marketing personnel and public relations.

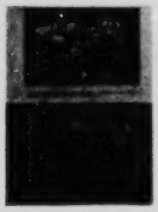


Fig. 1.11

In his book, Design This Day, Teague said that all problems in design were essentially the same. The same principles and approach to solving the problem would be similar if the problem has to do with a train, a skyscraper, or a grinding machine.

Fig. 1.12

Through industrail design, sales would increase by increasing the product's desirability. The aims of the designer would be to improve the product's appearance, improve servicability, and increase economy.

Teague has been called the "Dean of Industrial Deisgn."

Raymond Loewy

Fig. 1.13

Raymond Loewy is perhaps the designer best known to the general public. He was born in Paris in 1893 and came to America at the age of twenty-six. *He became a successful fashion illustrator* and earned an impressive $40,000 per year during the 1920's.

In describing how far a designer can go when styling a product, Loewy uses the term *MAYA*, which means *"Most Advanced Yet Acceptable"*. Products cannot be too advanced, or they may not sell as expected. There is an attraction to the new, yet a fear of the unfamiliar. Although there are no yardsticks or charted curves of public reaction to advanced design, the designer must develop a sense of consumer acceptance.

Fig. 1.14

Raymond Loewy has been recognized time and time again for creativity and design excellence. The *London Sunday Times Magazine* selected him as the only designer among "1000 Makers of the Twentieth Century." These people were individuals who have genuinely affected the life of ordinary people and changed the shape of the world, or at least caught our imaginations.

Fig. 1.15

Raymond Loewy's versatility as a designer is quite remarkable. The range of products that he has designed include packages, graphics, cosmetic kits, numerous household products, automobiles, buses, trains, ocean liners, and the interior of the space lab for NASA. He was author of the book, *Never Leave Well Enough Alone.*

Henry Dreyfuss

Fig. 1.16

Henry Dreyfuss left a successful career as a Broadway theatrical designer prior to becoming one of the pioneers in the profession of industrial design. In his book, *Designing for People,* Dreyfuss said, "Industrial design began by eliminating excess decoration, but his or her real job began when she/he insisted on dissecting the product, seeing what made it tick, and devising a means of making it tick better rather than making it look better." Dreyfuss worked to bring about a strong professional society for the industrial designer. *He was the first president of the Industrial Design Society of America.*

Fig. 1.17

Dreyfuss was one of the forerunners in the field of *Human Engineering.* He began collecting man's anthropometric, or human measurement information. In designing products he said, "We fit machines to men and never squeeze men into machines." This information was later published by the Whitney Library of Design under the title, *The Measure of Man, Human Factors in Design.* This publication is highly recommended for students designing products in industrial arts, vocational education, and art courses at the secondary school or college level.

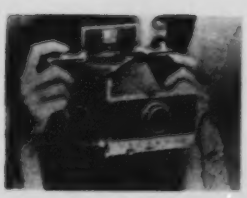


Fig. 1.18

His design philosophy was summed up as follows: "We bear in mind that the object we are working on is going to be ridden in, sat upon, looked at, talked into, activated, operated, or in some other way used by people. If the point of contact between the product and the people becomes a point of friction, then the industrial designer has failed. On the other hand, if people are made safer, more efficient, more comfortable – or just plain happier – by contact with the product, then the designer has succeeded."

AFTER THE PIONEERS

Following the efforts of the early pioneers in establishing the field of industrial design, many other consultant offices began to emerge. In addition, many corporations began establishing their own full-time design staffs. These corporate, or staff designers, were sometimes referred to as "captive designers." The term captive implied that the designer is owned by the company and limited in the range of experiences; these designers can't go beyond the company's needs.

Peter Muller-Monk

Fig. 1.19

Peter Muller-Monk was born in Berlin, Germany in 1904. In 1926 he came to the United States and *worked at Tiffanys as a silversmith.* He was one of the first industrial design educators. *In 1935 he helped to create the first program leading to a degree in industrial design at the Carnegie Institute of Technology, now Carnegie-Mellon University.*

He founded Peter Muller-Monk Associates in 1936, thus becoming one of the earliest practicing industrial designers. He was a prime mover in developing a strong professional society and was elected president and Chairman of the Board of the American Society of Industrial Designers, now IDSA, the Industrial Designer's Society of America.

Charles Eames

Fig. 1.20

Charles Eames, perhaps the greatest American furniture designer of our time, was born in St. Louis, Missouri. He was trained as an architect, but his versatility extends beyond architecture and furniture design to exhibit design and filmmaking.

Fig. 1.21

The Eames' chairs, many of which are part of the design collection of the Museum of Modern Art in New York City, are great not only because of the designer's phenomenal aesthetic sense and how the chairs support the human form, but for his innovative uses of materials and technology. For instance, plywood has existed for

years, yet Eames has extended the use of this material as a creative medium by molding the plywood to support the human body. He utilized the interesting grain of the wood as the chair's only decorative element. Shortly after World War II, he designed chairs using polyester with fiberglas reinforcement. This was one of the first consumer uses for this material.

Fig. 1.22

Eames views the design of furniture as architecture on a smaller scale. Making a chair comfortable merely by overstuffing it is a non-architectural solution to the problem. In our physiology we have a certain amount of bulk and certain points which take stress. The solution to the design problems depends on recognizing these points in supporting rather than conforming to the body.

George Nelson

George Nelson *studied architecture* at Yale University and did post graduate work at Catholic University. In 1947 he opened an office in New York for architecture and industrial design. *He has become one of America's most distinguished designers.*

Fig. 1.23

Nelson has had a long association with Herman Miller, Inc., one of the world's finest furniture manufacturers. He has designed many types of residential and office furnishings, including tables, bookcases, a variety of chairs, and wall storage units.

This couch is made with two-, three-, or four-seat units. It is constructed with chrome-plated steel and has a comfortable, rubber-strap suspension with loose, leather pillows. This couch is part of the Deisgn Collection of the Museum of Modern Art.

Fig. 1.24

Nelson designed the famous "bubble lamps" which are manufactured by the lighting division of the Howard Miller Clock Company. The design of this line of contemporary lamps is based on the Navy's method of mothballing ships. A self-webbing plastic is sprayed over objects and becomes a protective skin. In this case a warm, white, translucent skin is formed when sprayed over a metal cage. This softens incandescent light sources.

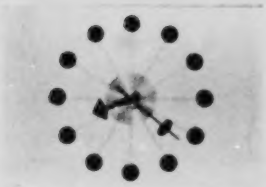


Fig. 1.25

Nelson has synthesized imagination and materials in the design of many contemporary clocks for the Howard Miller Clock Company. The famous "ball clock" insures functional readability as well as being a visual pleasing form.

George Nelson is author of *Problems of Design*, has written many articles, and has guest lectured at numerous colleges and universities.

Eliot Noyes

Eliot Noyes attended Harvard University and continued post graduate work in the Harvard School of Architecture. At Harvard he studied under Walter Gropius who had earlier founded the Bauhaus in Germany.

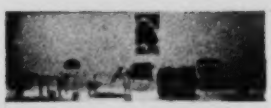


Fig. 1.26

In 1940 he became the first director of a design department at the Museum of Modern Art in New York City. In 1946 Noyes left the Museum of Modern Art to work for Norman Bel Geddes, a pioneer industrial designer. Noyes left Geddes and opened his own office in New Canaan, Connecticut.

Clients such as IBM and Westinghouse have their own design staffs and use Noyes as a consultant. However, most of his consultancies are to clients who do not have a design staff.

Fig. 1.27

Noyes is also a consultant to the Mobil Oil Corporation. In addition to service stations designed to improve appearance as well as enhance efficiency, he designed this unique gasoline pump. This pumper exemplifies corporate identity or that which is the immediate visual recognition of a company.

Today more and more products are designed by industrial designers. Many of the products we use directly and indirectly are made better through the work of present day designers who have evolved from the pioneers of the field.

EVALUATION

Questions 1–9

Place the letter representing the person who best relates to the description in each of the questions that follow. The names may be used more than once.

A.	Charles Eames	F.	Henry Dreyfuss
B.	Eliot Noyes	G.	Peter Muller-Monk
C.	Walter Dorwin Teague	H.	Raymond Loewy
D.	Norman Bel Geddes	I.	George Nelson
E.	Leonardo di Vinci	J.	Walter Gropius

1. _____ was described as the "Dean" of Industrial Design.

2. _____ helped establish the first Industrial Design degree program at Carnegie Institute of Technology.

3. _____ was the first director of industrial design in New York's Museum of Modern Art.

4. _____ opened the first Industrial Design office.

5. _____ a pioneer industrial designer who was a leader in the human engineering movement.

6. _____ is an artist, architect, and designer of some of the world's most famous chairs.

7. _____ was the author of *Problems in Design*. He studied architecture at Yale and designed many pieces of furniture for the Herman Miller Furniture Company. He also designed a number of contemporary clocks for the Howard Miller Clock Co.

8. _____ is perhaps the most well known to the general public. He uses the term MAYA. Some of his other clients include NASA, Coca-cola, and Exxon.

9. _____ was the author of the book, *Designing for People*. He also designed the telephone and products for Polaroid, and he was a leader in the human engineering movement.

10. Of the following groups, which were considered pioneers in the field of industrial design?

a. Noyes, Loewy, Eames, Nelson
b. Eames, Muller-Monk, Teague, Loewy
c. Loewy, Dreyfuss, Teague, Bel Geddes
d. Noyes, Bel Geddes, Dreyfuss, Nelson

11. The Bauhaus:

a. was founded by Walter Gropius.
b. when translated means "building house."
c. was an art university.
d. made machine tools of the artist.
e. all of the above.

12. Of the following backgrounds, which group best describes where the pioneer industrial designers came from.

a. architecture	d. fashion illustration	g. advertising art
b. law	e. medicine	h. theatrical design
c. electronics	f. fine arts	i. radio

(1st) a,b,d,h (2nd) c,e,f,g (3rd) a,d,g,h
(4th) b,c,g,i (5th) a,c,f,g

13. Industrial Design began as a profession around the time of the

a. Rennaisance
b. Industrial Revolution
c. World War I
d. Depression
e. World War II

14. Which of the following factors helped the Industrial Design profession to emerge?

a. The public may have been yearning for a change in the appearance of products.
b. Products became more and more competitive as the markets became saturated.
c. Appearance of a product had sales value.
d. a, c
e. a,b,c

15. The pioneer designers were generally unsuccessful in other fields and became industrial designers while searching to improve themselves.

a. True b. False

16. Today which of the following types of activities would the designers *least* likely to be engaged in?

    a. Improving old products
    b. Developing entirely new products
    c. Fashion design
    d. Exhibit design

17. Product design is almost never the work of a single individual.

    a. True b. False

18. Generally independent consultant designers are specialists and only design specific products. For instance, some consultant designers only design refrigerators, others only design chairs, etc.

    a. True b. False

19. The independent consultant often deals with new clients and is faced with unfamiliar problems. This continually presents a handicap for both the designer and the client.

    a. True b. False

20. A "captive designer" may be best described as:

    a. A designer convicted of industrial espionage
    b. A designer who holds a number of patents
    c. A staff designer employed by a company
    d. A designer who is married

ANSWERS TO CHAPTER I EVALUATION

The correct answers to the quiz are:

1.	C	11.	E
2.	G	12.	C
3.	B	13.	D
4.	D	14.	E
5.	F	15.	B
6.	A	16.	C
7.	I	17.	A
8.	H	18.	B
9.	F	19.	B
10.	C	20.	C

INTRODUCTION TO CHAPTER II

The illustrations which appear in Chapter II are included in the accompanying slides numbered 28 through 58.

OBJECTIVES:

1. *The student will be able to apply given criteria in the judgement of products to identify the products which best exemplify good design from within selected groups.*

2. *The student will be familiar with some products exemplifying good design and will be able to select the well-designed products from those of poor design from within selected groups.*

3. *The student will be able to answer specific questions describing the role which the industrial designer plays in product development.*

4. *The student will have a knowledge of words/terms used in the industrial design profession as indicated by the ability to identify each with its correct meaning.*

PRINCIPLES OF WELL-DESIGNED PRODUCTS

INTRODUCTION

The design process is a creative planning activity. The process is not to be equated with ornament or decoration. Design is not something put on a product before it goes to the marketplace. *Good design is built into a product, not draped on.*

The design-related problems of industry are many and varied. The industrial designer is most closely associated with a role in determining the forms that consumer and industrial products will take. The designer is not usually concerned with foods, but she/he is concerned with food processing equipment, packaging, and *the corporate image or the visual impression the corporation wishes to project.*

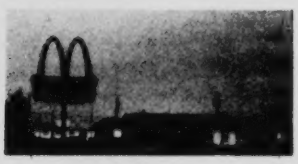


Fig. 2.1

The designer is not concerned with raw materials; the concern is with the equipment used to extract, convert, and transport the raw materials. The designer's primary concern is with the visual aspects of the product rather than with electrical systems, power transmission, or detailing production information.

Fig. 2.2

In designing or judging a product, we may look for principles to follow for considering its qualities. Ten principles generally considered important to product design are: *(1) humanization; (2) product aesthetics (3) maintainability; (4) economy in the use of materials; (5) selection of materials; (6) creativity in the design solution; (7) part-whole relationships; (8) the purpose of an object; (9) integrity in the use of materials; and (10) form and function relationships.*

DESIGN PRINCIPLE NO. 1 – HUMANIZATION

Fig. 2.3

Unlike other living creatures on earth, humans are one of the most fragile and ill-adapted to the environment. They have none of the natural protective devices bestowed on other animals such as shells, camouflage, fur, and keen senses of sight and smell. Born helpless, humans have one capability unknown to the rest of the animal world, the potential to develop a high degree of intelligence. With this they can reason, plan, develop concepts, and improve their environment to suit their needs. Their clothing, dwellings, modes of travel, and technology illustrate how they improve their immediate environment. This interaction with

our environment is known as human engineering. *Human engineering means fitting the machine to the person and keeping the person functioning with efficiency, safety, and as comfortable as possible both physically and psychologically.*

In the early days of the industrial design profession, products were designed with emphasis placed on production methods, profit motives, and styling the visual aspects of the product. Today, human engineering is also emphasized as a valuable technique and is a standard practice in any good design office.

HUMAN ENGINEERING
- Auditory Signals
- Visual Displays
- Manual Controls
- Environment
- Anthropometric Conformity

Fig. 2.4

Human engineering considerations, which are important when designing a product, fall into the general categories of auditory signals, visual displays, manual controls, environment, and anthropometric conformity.

Auditory signals include sounds such as reproductions of speech and warning sounds. Different types of sounds represent different degrees of emergency. For instance, chimes are used in non-urgent actions and do not cause undue alarm. Bells, on the other hand, are penetrating and demand a faster response. Audio sounds must be sufficiently louder than the existing normal noise level to be effective. However, they must be confined within the maximum human threshold to avoid injury to the operator.

Visual displays are concerned with graphic or pictorial information such as dials, letters, numbers, counters, and signal lights. The most important and frequently used instruments should be located nearest the operator's normal line of sight.

Fig. 2.5

Manual controls are concerned with the sizes and shapes, as well as location, of knobs, levers, and pedals. Basic grips should conform to the hand of the user. The amount of force necessary to operate controls is also an important consideration because the human operator should not be expected to perform at maximum capacity for any great length of time. These recommended forces must be considered when using such items as push buttons, toggle switches, hand wheels, and gear shift levers. The most frequently operated controls should be located in the most accessible positions and be within the normal reach of the operator.

The environment must be as normal as possible in order for man to function efficiently over a long or short period of time. This includes air temperatures, vibrations, noise levels, gases, restful colors, and adequate light.

Anthropometry refers to human body measurements. Anthropometric data, or human measurements, provide information to aid in developing products to fit the human user.

Fig. 2.6

The anthropometric problem is compounded when many individuals use the same product. For instance, the telephone must be operable by virtually everyone. Its uses range from conversations to extremely urgent matters of life and death. The telephone must fit a tremendous variety of hand and head sizes as well as having auditory signals within a comfortable range. It was developed by Bell Telephone Laboratories in collaboration with Henry Dreyfuss Associates.

DESIGN PRINCIPLE NO. 2 – PRODUCT AESTHETICS

Fig. 2.7

Industrial designers are artists in industry. An artist gives form to something which has an aesthetic value depending on its ability to evoke a response through visual impact to the beholder.

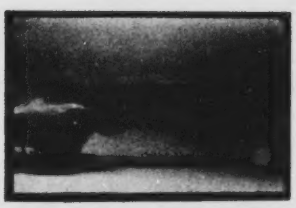


Fig. 2.8

Beauty is the promise of function. This may be described as a product achieving a form symbolizing the work it will do. If a product is intended to convey ruggedness, then those qualities must be conveyed by the selection of materials, structure, and finish, as well as by the proportions and detailing of the product . . . A tank may be fearsome, yet beautiful . . . . an axe, or a target pistol may achieve beauty, not because they are pretty, but because they *look* as though they were made to perform the work they do.

American design began when it was felt that products which looked better would sell better. Prior to the beginning of the design profession in the late 1920's, if a product functioned satisfactorily, its visual appeal was secondary. Now, with many competitive products performing equally well, the success or failure of a product in today's market is strongly influenced by appearance.

Appearance is often the basis for the consumer's choice in selecting a product. The designer's skill is the only one in the product-making process that is responsible for aesthetics. He or she is concerned with the texture, form, and color as well as the selection of materials for production.

Fig. 2.9

The Barcelona chiar was designed in 1929 by Mies Van der Rohe. This classic chair is still manufactured and represents the highest achievement in coordination of materials, craftsmanship, and design.

DESIGN PRINCIPLE NO. 3 – MAINTAINABILITY

Fig. 2.10

Easily maintained products have definite advantages over those which are more complicated to maintain. Before a product is purchased, a consideration should be given by the potential buyer as to how much maintenance one will have to go through periodically or after using the product. This outdoor light is made of Cor-ten steel. This material has the unique characteristics of protecting the interior part of the steel with the normal oxidation which takes place on the surface. In industrial products an added problem to complicate maintenance is that of *cost. Not only are labor costs extremely high, but when machines and equipment are undergoing repairs or periodic maintenance, they may not be producing.*

The lack of income from the "idle machine" coupled with high labor costs can be disasterous to a company.

Fig. 2.11

The domestic consumer, like the industrial purchaser, is aware of the high cost of service repairs. *Another concern is the effort* one must go through to keep the product maintained. The stainless steel flatware has smooth lines which are easily cleaned; they don't have intricate places where food can gather. Special care other than normal washing is not required.

Many of our household appliances are engineered to minimize or reduce maintenance. Self-defrosting refrigerators and freezers and self-cleaning ovens influence the purchaser because of the ease-of-maintenance principle.

DESIGN PRINCIPLE NO. 4 – ECONOMY IN THE USE OF MATERIALS

Fig. 2.12

Buckminster Fuller said, "We must learn to do more with less." This is one of the many versions of Fuller's Geodesic Dome. The structure, which through a balance of forces, provides maximum enclosures of space with minimum material.

Using materials economically, yet enough to insure a properly functioning product, can derive several benefits for the manufacturer. *It can give greater profit or lower the cost of the product, which often captures a larger percentage of a given market.*

Fig. 2.13

Economy in using materials may be exemplified by transmitting more information with a communication satellite weighing hundreds of pounds than with a trans-Atlantic cable weighing thousands of tons. As we find ourselves facing various material and fuel shortages, we must plan carefully for production in order to minimize waste, gain efficiency in equipment use, and recycle materials.

Fig. 2.14

Often, common items such as paper clips, needles, and pins exemplify excellence in design and creativity. These everyday products are reduced to an absolute minimum of material usuage.

Fig. 2.15

Technological advances in the minaturization of products exemplify economy in the use of materials. One such advance in the electronics industry is called "chip circuitry." This miniaturization of electronic circuits makes it possible to develop products such as the pocket calculators. The extremely small electronic circuits allow products to be manufactured in small, compact units with pehnomenal capabilities. The location of the tiny electronic circuit is the small area indicated at the point of the pencil.

DESIGN PRINCIPLE NO. 5 – SELECTION OF MATERIALS

Fig. 2.16

In selecting the materials for a product, consideration must be given to the task which the product will perform in addition to the environment which will surround it. The materials selected for a ship propeller must be long lasting under the adverse conditions of salt water. Its beautiful form evolves from the function it performs with no extraneous decoration. When selecting materials, the manufacturing capabilities of the manufacturer must be taken into consideration.

Fig. 2.17

The material selected for the outdoor phone booth requires very little maintenance. Materials such as aluminum, stainless steel, and glass are weather resistant. Replacements of the broken windows are relatively easy. The physical size of the phone booth is rather confining, yet it has the illusion of being spacious because of the extensive use of glass. This transparent feature also provides safety for individuals because one can easily see inside while walking or driving by. It was developed by Bell Telephone Laboratories in collaboration with Henry Dreyfuss Associates.

Fig. 2.18

Materials may be selected because of cost, availability, weight, or because they possess certain characteristics which offer unique design possibilities. Aluminum is a relatively soft metal which has the capability to leave a built-in weakness in the top of the can.

DESIGN PRINCIPLE NO. 6 – CREATIVITY IN THE DESIGN SOLUTION

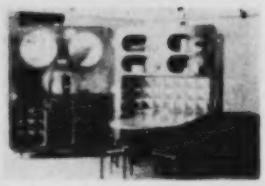


Fig. 2.19

Improving old ideas and creating new ones is one charge of the designer. S/he is a problem solver. One asset of the independent consultant designer is the general knowledge of materials and fabrication techniques that come from constant work on a wide range of products. Often companies get too close to their own problems and a "fresh outside view," or detached perception, from someone not involved in the day-to-day details of the corporation's existence can often solve these problems quicker and easier.

Designing may be described *as creative planning* to meet a specific need. The word creative denotes an original treatment to the problem or task. The designer must combine his/her creative talents with those of other members of a team including engineers, factory specialists, and marketing experts.

Fig. 2.20

A chair which can be stacked utilizing a minimum of space is shown here. A specially designed dolly holds 40 chairs in a 4-foot high stack.

INDUSTRIAL DESIGN ACTIVITY

CREATIVE PROBLEM-SOLVING ACTIVITIES

The projects are offered with various degrees of difficulty and involve several engineering principles. Consideration is given to expense, thus some projects can be accomplished with very little or no cost at all.

The teacher should be aware of the value of fun and humor in projects. Most of us, who enjoy doing certain things, will be highly motivated and can learn a great deal in the process. Divergent, or unusual solutions, should be encouraged to foster creativity. When students present their solutions, an extremely valuable and enjoyable experience can be had by all.

THE MOUSETRAP MOBILE

Design a method to transport a brick (weighing 6 pounds) a distance of 13 inches over a relatively smooth, level floor. The source of power to be used is a standard, regular, normal, everyday, no-nonsense mousetrap.

EGG PACKAGE

Design a package which will contain three medium size, natural, uncooked chicken eggs. The package must protect its contents when thrown or dropped from a height of eight feet onto a hard surface such as concrete or blacktop. The volume of the package may not exceed 100 cubic inches. Food stuffs, such as jello, may not be used.

A second part of the problem is to design a device which will throw the package a minimum height of eight feet into the air. The throwing device may not exceed three pounds in weight.

The second part of the problem may be omitted if the teacher chooses to allow the students to drop the egg from a second story window onto a hard surface.

THE FIREMOUSE

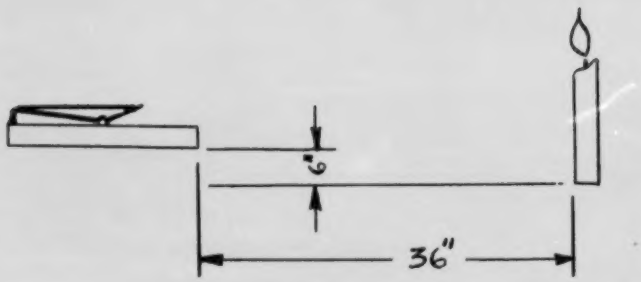
The Design Problem

Design a device utilizing a mousetrap which will put out the flame of a typical birthday candle.

Time Limitations

The device has to put out the flame within the limit of the candle's normal life. If the flame goes out of its own accord, the student will not have met the problem requirements.

Project Limitations



1. The only source of energy allowed is a typical mousetrap.
2. A maximum of $1.00 can be spent including the mousetrap.
3. No group projects.
4. The operator cannot put the mousetrap within 36" of the candle. The mousetrap can be ± 6" from the base of the candle. (See diagram)
5. The operator gets one chance to put out the flame without penalty. Then each attempt is penalized.

DESIGN PRINCIPLE NO. 7 – PART-WHOLE RELATIONSHIPS

A product may be viewed as a unity of its parts in relationship to its wholeness. Attention must be given to each of the details such as levers, dials, buttons, etc. to ensure a visually pleasing proportion to the whole product.

Fig. 2.21

The lounge chair and the ottoman were designed by Charles Eames to be seen as well as to be used. It is made of molded rosewood plywood with black leather cushions. The curved shape of the top part of the ottoman is very much in keeping with the curved shape of the chair seat as well as the back and head rest. The design of the cast aluminum swivel base on the chair and the ottoman provides a good visual relationship to each piece. The base on the ottoman is smaller and rests on

four points which is quite sufficient for function. The base of the chair rests on five points and is larger because of the heavier weight that it must carry. The two pieces seem to flow into a "oneness" of compatibility and beauty.

Fig. 2.22

In looking at nature, we find countless examples of part-whole relationships. In animals we find the parts elongated or shortened as the species requires. The neck of the swan and that of the eagle, although different in character and proportion, are aesthetically pleasing in relationship to the whole animal.

DESIGN PRINCIPLE NO. 8 – THE PURPOSE OF AN OBJECT

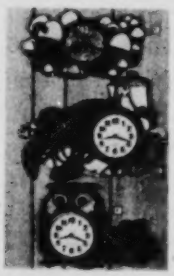


Fig. 2.23

The purpose of an object may be described as never making an object seem to be what it is not. We need only to walk through many department stores or look through sales catalogs to find countless violations of these principles.

The poorly designed clocks represent an immature design direction. By making the product seem to be something it is not, its standard of design has been reduced to the lowest level.

Fig. 2.24

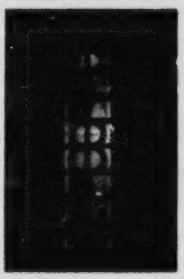
In contrast to the poorly designed clocks, the lamp shown here is a beautiful object in itself. The graceful lines of a well-proportioned base flow into the lines of the glass bulb on top. This expresses its purpose.

This classic chair compares to the natural growth of a tree because of its organic form. Its wide base appears firmly rooted in the ground and seems to unfold like a leaf or blossom as it curves upward. The armchair is molded plastic, reinforced with fiberglass, and has a painted aluminum base.

Fig. 2.25

DESIGN PRINCIPLE NO. 9 – INTEGRITY IN THE USE OF MATERIALS

A design should be an expression of its material, not an external attempt at decoration or imitation.

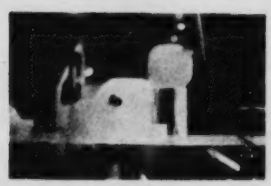


This architectural glass, designed by Peter Muller-Monk, illustrates how well-designed products use materials honestly and try *not to make them imitate other materials.* The design of a product uses a material to express the main characteristics and function of that material. *Questions of honesty or integrity are raised when wood is stained to imitate another wood, printed with woodgrain patterns, or plastic impregnated with wood grain.*

Fig. 2.26

An exhibition entitled "Plastic as Plastic" implies that plastic can be used in product design with integrity. Plastic was used in manufacturing numerous products. In each case the plastic was used as a beautiful material appropriate to the design of the product. Plastic was never reduced to an imitation of something else.

Fig. 2.27

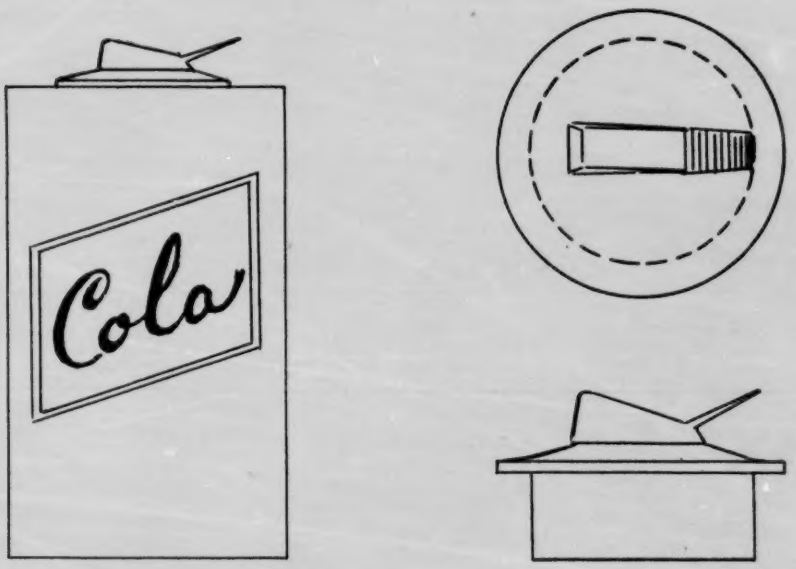


All materials have certain unique characteristics which are appropriate to certain manufacturing techniques; these characteristics should be taken advantage of *with integrity.*

Fig. 2.28

INDUSTRIAL DESIGN ACTIVITY

Redesign the lighter shown below. Keep the standard lighter insert and indicate, by a note, the materials which the new design will incorporate.



DESIGN PRINCIPLE NO. 10 – FORM AND FUNCTION RELATIONSHIPS

Fig. 2.29

A product's function is the performance of the task for which it is designed to fulfill. Its form should grow out of its purpose or function. The designer's task is to analyze this function and develop a pleasing form in relationship to the human element, as well as to other products in its environment. *Function alone is no guarantee of good design – it is merely the basic level at which something can go without failing to serve its purpose.*

Fig. 2.30

The beauty of the bow is shown in the graceful lines of the recurved lamination which adds thrust to the arrow released. The sculptured handgrips are designed to retain control at all times.

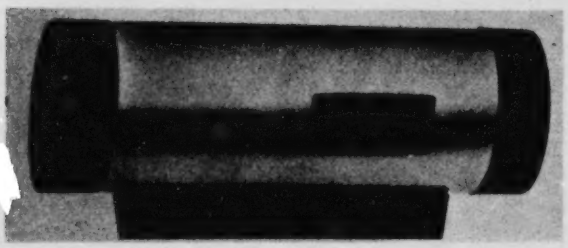
Fig. 2.31

The Boston Whaler exemplifies form and function relationships. When it entered the market in 1958, many competitive boats were styled with tailfins. Tailfins, of course, were merely decorative and performed no function to the operation of the craft. This boat is extremely reliable, even in bad weather, and is virtually unsinkable. It beautiful form and excellent use of material make it one of the most copied boats in the world.

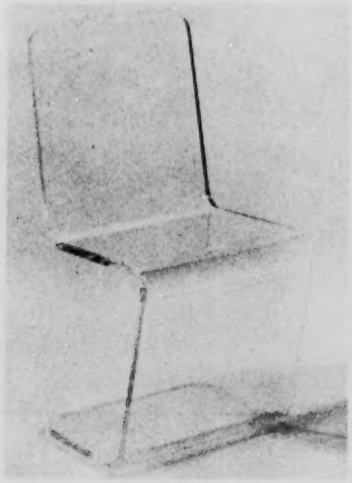
The ten principles of well-designed products presented here are generally considered important. However, some products, by their very nature, violate several of these principles. Some caution must be used in applying these principles to all products; there are exceptions.

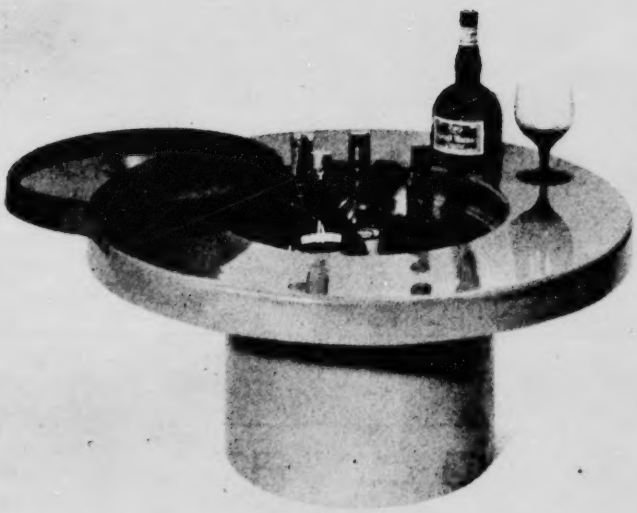
INDUSTRIAL DESIGN ACTIVITY

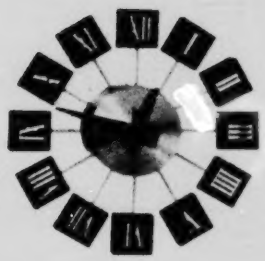
Critique the following products based on the principles given in this chapter.



INDUSTRIAL DESIGN ACTIVITY



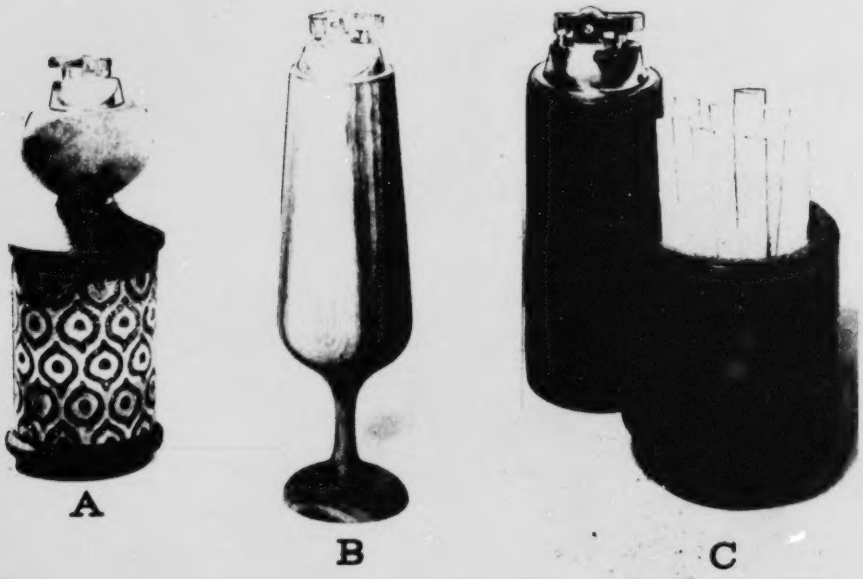




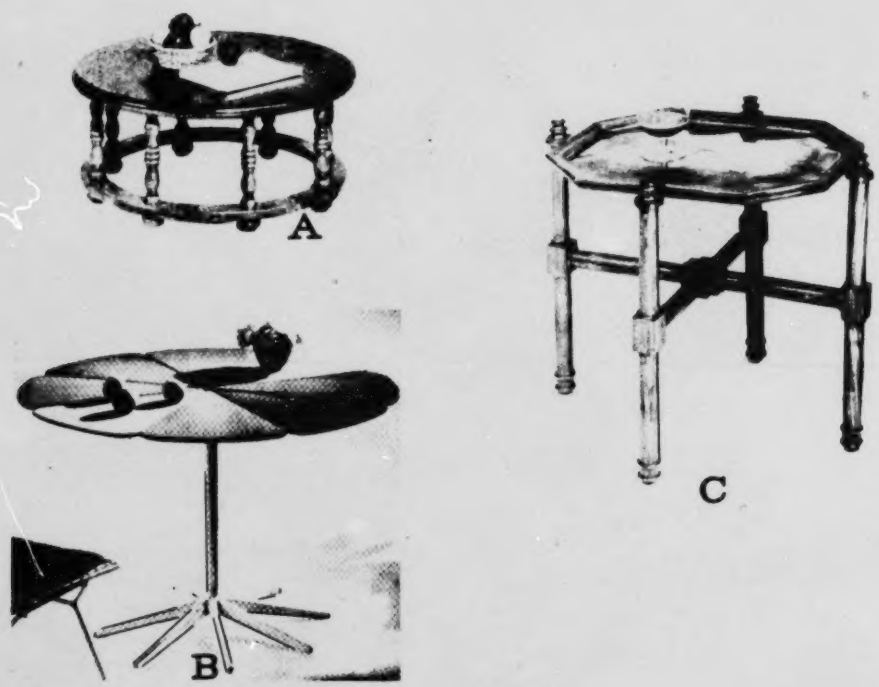
28a

EVALUATION

1. Of the table lighters shown, select the one which exemplifies the poorest design.

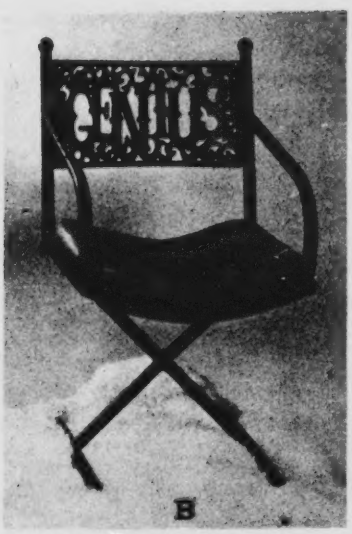


2. Of the tables shown, select the one which exemplifies the best design.



3. Of the products which follow, select the one which exemplifies the poorest design.

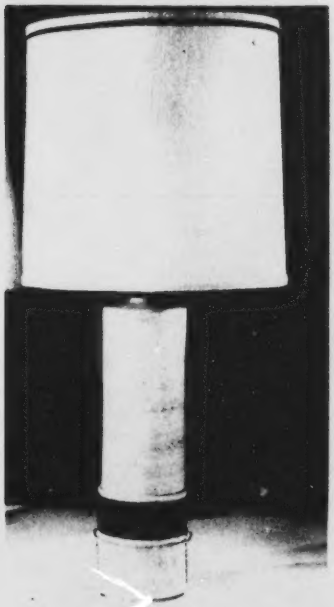
A



B

C

4. Of the lamps shown, which one exemplifies the best design?



A

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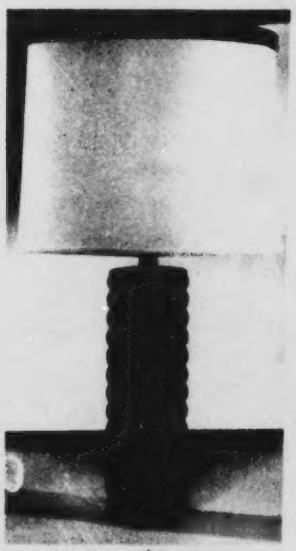
5. Of the products which follow, select the one which best exemplifies the principle of "humanization".

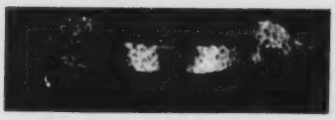


A

B

6. Of the products which follow, select the one which best exemplifies the principle of "economy in the use of materials."

A



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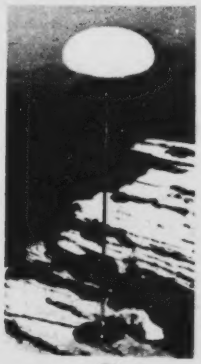

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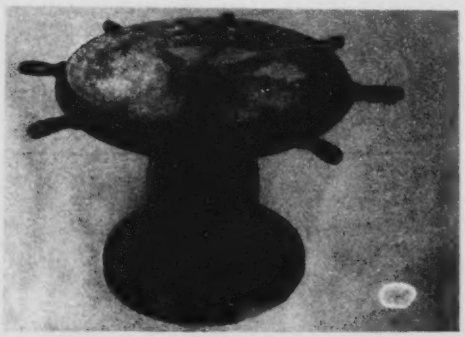
7. Of the products which follow, select the one which best exemplifies the principle of the "purpose of an object."



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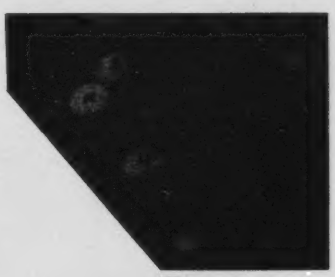

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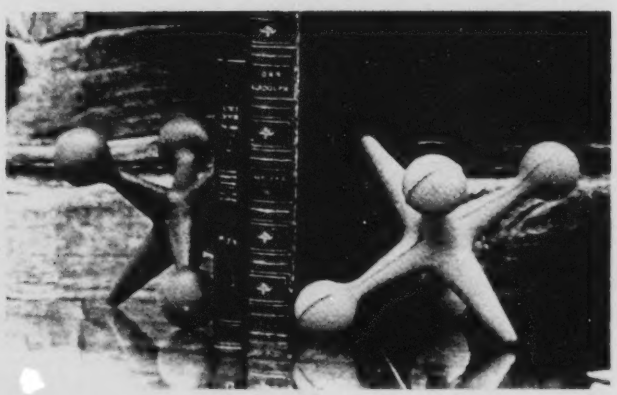

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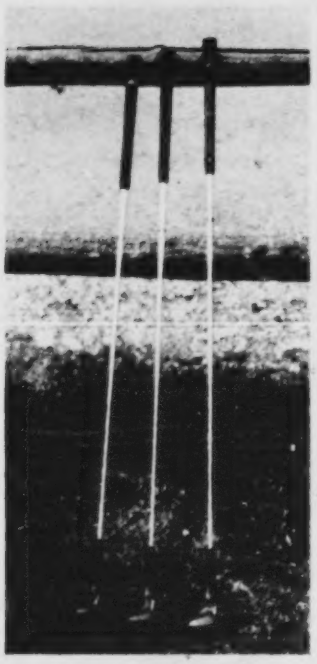
8. Of the products which follow, select the one which best exemplifies the principle of "form and function relationships."



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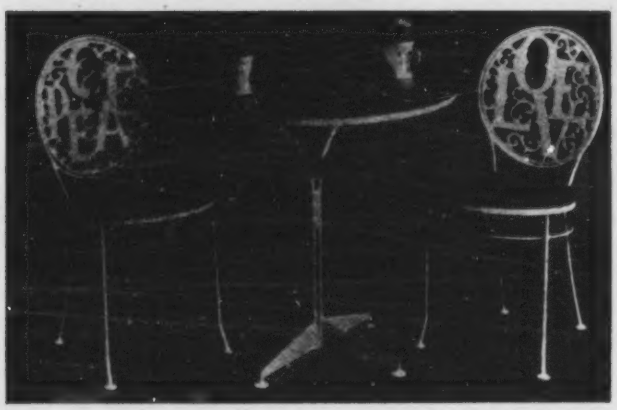
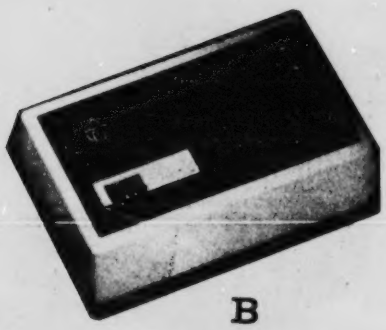


C

9. Of the products which follow, select the one which best exemplifies the principle of "product aesthetics and creativity in the design solution."

10. Of the products which follow, select the one which is the best combination of the principles of "part/whole relationships and integrity in the use of materials."

A



B

C

11. Industrial designers may be best described as:

a. craft workers b. engineers c. architects
d. artists in industry e. model makers

12. Industrial designers are involved with products which are mass produced.

a. always b. mostly
c. sometimes d. never

13. Industrial designers would most likely be called on to:

a. redesign old products/design new products
b. design machinery/solve design problems
c. design small airplanes/design men's fashion
d. a and b
e. a, b, and c

14. Which of the following products would the industrial designer be *most* likely to be involved designing?

a. zipper b. golf ball c. printed circuit
d. toy e. auto alternator

15. Which of the following products would the industrial designer *least* likely to be involved designing?

a. french horn b. electric drill
c. television set c. perfume bottle

16. The term used when designing a machine to fit the person and keeping him/her functioning with safety, efficiency, and comfort is:

a. anthropometry b. human engineering c. visual display
d. industrial design e. all of these

17. The aesthetics of a product is essentially its:

a. value b. function c. market success
d. texture e. pleasing appearance

18. The science dealing with dimensions of the human body is:

a. anthropometry b. human engineering c. visual displays
d. industrial design e. all of these

19. In human engineering, the term visual display is used for:

a. sales displays
b. convention exhibits
c. graphic information on equipment
d. advertising
e. all of these

20. Corporate image is best described as

a. the architecture of the building
b. the visual impression the company projects
c. the company trademark
d. photographs of the company

ANSWERS TO CHAPTER II EVALUATION

1.	A	11.	D
2.	B	12.	B
3.	B	13.	A
4.	A	14.	D
5.	B	15.	A
6.	C	16.	B
7.	B	17.	E
8.	A	18.	A
9.	B	19.	C
10.	A	20.	B

INTRODUCTION TO CHAPTER III

The illustrations which appear in Chapter III are included in the accompanying slides numbered 59 through 80. This chapter has suggested questions which may be used for student discussion. The answers are stated in this teacher's guide, however, they are written into the text of the student manual.

OBJECTIVES:

1. *The student will have a knowledge of techniques used by the industrial designers in developing products as indicated by the ability to answer questions concerning methodology.*

2. *The student will be able to choose the best way to state problems into phraseology which avoid stereotyped solutions.*

3. *The student will have a knowledge of selected words and/or terms used in the industrial design profession as indicated by the ability to identify each by its correct meaning.*

4. *The student will be able to answer specific questions describing the role which the industrial designer plays in product development.*

Chapter III

INDUSTRIAL DESIGN CASE STUDIES

THE RIDE'N HIDE TOY BY CREATIVE PLAYTHINGS

Fig. 3.1

In October 1973 Creative Playthings felt that a void existed in their product line for a unique, ride-on toy. The company had produced the "crawliagator", which is a ride-on made for children ranging in ages from 6 to 18 months. The new product they envisioned would be intended for slightly older children from two to five years of age.

Questions

Which of the following decisions would you make? Would you enlarge the "crawligator" toy to fit the anthropometric data, or body measurements, of an older child, or invest the time, effort, and money required to develop an entirely new product?

Answer

Creative Playthings decided to develop a new product. Merely enlarging the crawligator would be inappropriate because older Children wouldn't ride the toy by laying on it as a nonwalker or a toddler would.

Fig. 3.2

The new product would be designed by corporate designers who are permanent staff designers employed by the company. The new product would have to project a high-level corporate image, or good visual impression to the public. It would have to be simple, sturdy, safe, and of high quality construction. In addition to these basic requirements, it would be a ride-on toy, and possibly have a versatile function of doing something else. This would make it more unique in the marketplace. Of course, a most important requirement for any successful toy is that the child must enjoy playing with it.

Question

If you were a designer at Creative Playthings, would you make elaborate sketches in perspective, and perhaps in color, or would you make rough sketches to discuss with other designers?

Answer

The designers at Creative Playthings communicate with rough sketches. Small design staffs can communicate informally. Elaborate sketches may be correct if you are an independent consultant designer retained by a company to design a product and you are presenting your ideas to them. Sketching was done quickly in the form of "doodles" with little attention paid to techniques. The sketches were used only for the design staff to communicate to each other. The designers at Creative Playthings are three-dimensionally oriented. They prefer to work with models rather than drawings. If a presentation must be made to management without sufficient time to construct a preliminary study model, a more elaborate sketch or drawing may be used. Models at Creative Playthings are always full size rather than to scale. Scale models are either larger or smaller, but in proprotion to the actual size.

Fig. 3.3

The office chair with wheels was the inspiration for the initial solution to the problem. Sometimes children and adults, in a moment of frolic, race around in a backward, gliding movement made by pushing with their feet. One designer recalled that it was fun, and that kind of movement would be fun for a child. Toy designers must have an imagination which can relate to the play of children, but they must also think technically to arrive at the right combination of materials, color, function, size, weight, and design for each and every toy. Many psychologists feel that good toys are "open ended," that is, they allow the child to use his or her imagination. They are the toys that actively involve the child.

Fig. 3.4

The first preliminary model was intended to be used in several ways. The child could sit and straddle the toy, using one part as a backrest. Later he or she could use it almost as an armchair. It was constructed of particle board which could be used indoors as well as outdoors. Although the shape was simple, it was a little difficult for a child to mount.

Question

What would you do at this point? Would you continue to refine the design, begin cost analysis for production, or begin engineering the product, such as specifying materials and making detail drawings of the parts?

Answer

The designers continued to refine the design. The fact that the child would have difficulty in mounting the toy indicates that the design was not as good as it could be.

Fig. 3.5

The design was refined, keeping the handle and three wheels. While making it easier for a child to mount, the choice of casters also changed. This particular model was a little small for the anthropometric considerations, or body measurements, of the child. By raising the seat, a cavity was created which provided a natural storage space. Then someone had the idea to add blocks to it; this also made it a building toy.

Then someone thought of the name "Ride 'n Hide." This name as most product names at Creative Playthings was created by the designers. This particular name suited the product because the child could ride it and store blocks inside. The product had sort of an abstract look, yet it had the appearance of a vehicle.

Fig. 3.6

As the project progressed, the designers asked, "What can we do to make it more unique?" Then came a definite alteration in the design. The "fluidity" in the movement of the casters make it extremely easy to push in any direction. This influenced the shape of the product to be non-directional by not having any specific front or back. A string was added to make it a pull toy. Nothing was added to the end of the string such as a ball or object; this could make the toy a safety hazard because children could choke themselves by easily tying a knot. The designers felt that proportionally it seemed a little small. It also seemed a little high, making it somewhat unstable. This feeling of smallness was not based on human dimensions. Making it a little larger would gain more visability in the marketplace.

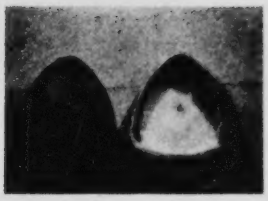


Fig. 3.7

In going to a larger form, polystryrene was selected instead of wood. This made it easier to manufacture and it helped give Creative Playthings a new identity by going beyond what was almost a complete wood-product image. It would also be easy to maintain. The polystyrene foam was available in standard colors of blue, red, and yellow. Molding it in color would eliminate the need for painting, thus saving production costs.

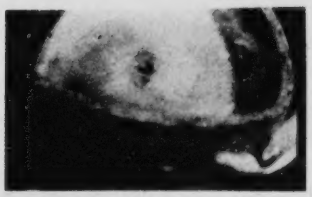


Fig. 3.8

As a designer, would you have approved the blue as shown, or would you have investigated other colors?

Answer

The designers chose to investigate other colors. In this case they felt that the blue was undesirable because of the "marbleizing" appearance of the material.

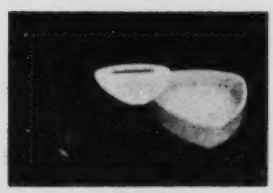


Fig. 3.9

This may have been acceptable for some products, but it was felt to be undesirable because of the color distortion. The red was not particularly desirable. Without going to a more costly special mixing, the yellow appeared a suitable color. The "marbleizing" was much less noticeable in yellow. However, the white top was not as desirable with the yellow as it was with the blue.

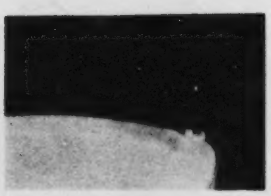


Fig. 3.10

Another consideration was the standard colors of the casters. Without going to the added expense of ordering special colored casters, the choice was limited to light gray, black, tan, and brown. The designers felt that the brown casters best complemented the yellow body. The problem remained to select a color for the top which would be playful, compatible with the brown and yellow colors, inexpensive, and still could be expected from Creative Playthings.

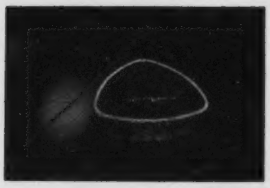


Fig. 3.11

After experimenting with many colors, a decision was made to use orange. At this point the design had reached its final form in three dimensions. From this model, contour drawings were made. Designers make contour drawings which control the shape with general dimensions, but they are not detailed as much as production drawings. These are then turned over to the engineering department; they convert them to working drawings including all specifications, dimensions, and details. The designers remain the "aesthetic guardians" over the product; they have final approval of the drawings prior to production.

Question

At the time production was to begin, there was a material shortage of polystryrene from the supplier. If you had to make the decision of what to do because of the material shortage for an indefinite period of time, which of the following choices would you make?

1. Would you wait until the material was available?
2. Would you try to find a suitable substitute?
3. Would you begin the entire process over?

Answer

The search began for a suitable substitute. Neither of the other choices was acceptable. Beginning the process over would be appropriate if the design was not good, and any other number of materials might be acceptable alternates.

Fig. 3.12

Polyethlene was substituted for the polystyrene. The yellow polyethlene had a richer color and is more pleasant to touch. The material costs were comparable.

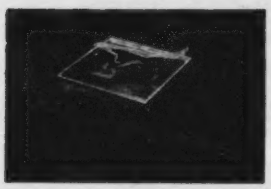


Fig. 3.13

The package design was created by the Graphic Design Department, which is near the Industrial Design Department at Creative Playthings. This department is also responsible for sales displays and exhibitions as well as designing packages for the products.

Fig. 3.14

The final product became a combination pull toy, storage toy, and ride-on toy. Original projections were to produce approximately 50,000 "Ride 'n Hide" toys per year. It was introduced at the 197[illegible] Toy Fair.

A RADIAL ARM SAW BY DEWALT

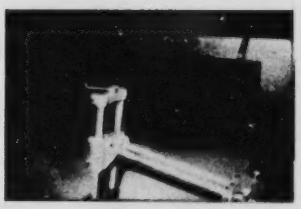


Fig. 3.15

The DeWalt Company manufactures a line of high-quality, radial-arm saws. They are expensive, and the company felt a market existed for a low-cost model. The engineering design of their existing radial-arm saws did not allow sufficient cost reduction. This was due primarily to the expensive horizontal arm, along which the saw traveled. It was a large iron casting with machined parts. DeWalt's engineering department developed a way of using two pieces of pipe to replace the more expensive casting. This is a functional model made by the company.

Question

If you were a DeWalt executive who had to recommend how this product would be developed, would you:

1. Manufacture the product as is.
2. Employ one or more full-time designers to work for the company.
3. Retain a design consultant.

Answer

A decision was made to retain a design consultant. In this case, only one product is in question. This would not warrant employing full-time individuals. By retaining a consultant, a corporation can draw on the expertise of individuals with a wide variety of experience. This is often less expensive than employing full-time personnel.

The DeWalt Company retained Harper Landell and Associates to design a low-cost radial saw. The company gave the designer the functional model which performed at a minimal level. Landell's task was to take the model and develop it into a marketable product.

Question

If you were a design consultant, would you accept the engineer's dual-pipe, horizontal, supporting system?

Answer

Although this may eventually prove to be the best system, the designer should seek other methods which would be more effective or less expensive.

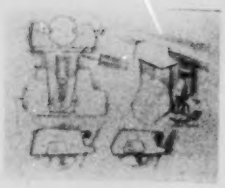


Fig. 3.16

Landell utilized the method of sketching during preliminary thinking stages to arrive at tenative solutions to problems. The overall problem, including the two-pipe principle, was analyzed. The designer recommended using a larger, single pipe which would have the strength of the two, and would eliminate the problem of holding the two pipes parallel. Sketches showed what the form might work as well as selecting the methods most advantageous in manufacturing.

During the sketching phase, ideas were generated to solve appearance problems, such as how the saw will swivel and change angles for different cuts. These preliminary sketches were refined by the designers and presented to the client. They were discussed with management and engineering to insure that the company's satisfaction with the design and to insure that the product maintained feasibility within the company's manufacturing capabilities.

Question

After the sketch has been approved, would you refine the design further, or would you begin tooling for production?

Answer

After the sketch or design direction has been approved, the design must be refined further. Tooling would be premature because all mechanical problems have not been worked out, nor could accurate specifications be determined from the sketches. Other specialists, such as marketing experts, should also have input to the project prior to final tooling.

Fig. 3.17

Sketches may be refined, incorporating revisions which may involve less expensive production, improved functions, or improve the product in some other way. These are synthesized into a more comprehensive drawing called the rendering. It is an accurate representation of the product showing how it will look when produced. Renderings are drawn in perspective and often incorporate color. Marketing and sales were brought into the project at this time.

Fig. 3.18

Preliminary mechanical drawings were made to refine the product's form and provide dimensions for building a full-size model. An appearance model was then made.

Question

If you were making a model, would you make the model out of any materials which are easy to use and can be painted or treated in some way to simulate the actual material? Or, would you make the model out of the materials which would be used in manufacturing the product?

Answer

Models are made out of any easy-to-use materials to simulate the actual material. When making a model, actual production parts are used only if they are, or can be modified to be, exactly what the new design requires. Other parts are made of plaster, plastic, or other easy-to-use material to simulate the metal die casting and other parts. Lettering on the name plates was done by hand. This does not violate the design principle of integrity in the use of materials because it is a developmental model, not an actually manufactured product made with parts which imitate another material.

Fig. 3.19

The saw was color styled to be compatible with other products sold by a DeWalt subsidary, the Black and Decker Company. However, when the DeWalt executives saw the model, they felt that perhaps they would keep it in the DeWalt product line. A different color was then selected as well as different graphics to keep the corporate identity, or the visual recognition, of a DeWalt product.

Fig. 3.20

A model offers a basis for a better evaluation of the product's aesthetics because it can be viewed from every angle. It also provides engineering with a precise idea of how the product will be manufactured, allowing an accurate estimate for tooling and manufacturing costs since it represents the exact size and shape of the product. The model also offers a check of human engineering considerations. In this case the human factors primarily concern themselves with accessibility to controls and user safety.

Question

As a DeWalt excecutive, would you consider the design aspects of the project closed or investigate other possibiliites?

Answer

DeWalt investigated other methods of marketing to increase sales. The corporate executive had the responsibility to investigate all possibilities of increasing sales and profits.

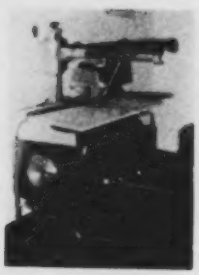


Fig. 3.21

Consideration was then given to manufacturing the product under a private brand name in addition to DeWalt. Products sold in large quantities under a brand name usually function as well, but they appear different. This is usually done with minimal tool changes in order to make it look as though it was produced by another company. In this case the saw was considered for the J.C.Penny Company. It would be sold with their label on it. DeWalt had a stand for the saw; however, a new low-cost stand would be designed for the brand name. Landell and Associates drew on their experience in television stands and designed a stand utilizing tubing. This stand could be manufactured for approximately one-third the cost of a sheet metal stand. Although the J.C. Penny adaptation of the product was investigated, the product never went into production under their name.

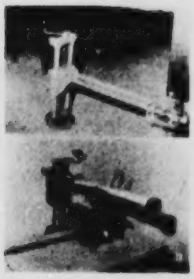


Fig. 3.22

The final DeWalt radial saw was recognized for excellence in design by the Machine Design Division of the American Society of Mechanical Engineers.

EVALUATION

1. Preliminary study models represent the final product in precise detail.

   a. True b. False

2. Scale models are always smaller than the actual product.

   a. True b. False

3. Models are sometimes made of different materials other than the actual manufactured product.

   a. True b. False

4. A rendering is:

   a. A service rendered by a design consultant.
   b. An accurate representation in color and perspective of what the product will look like.
   c. A preliminary model.

5. When a designer is given a problem, he or she must visually stay within the company's original thinking regarding the products design.

   a. True b. False

6. State the following methodology in the order which it would most logically occur.

   (1) Rendering (2) Contour drawings
   (3) Preliminary model (4) Sketching

   a. 4,3,1,2 b. 3,2,1,4 c. 1,2,3,4, d. 4,3,2,1

7. Designers often sketch as a method to:

   a. Solve appearance problems
   b. Solve technical problems
   c. Both

8. A finished appearance model is used:

   a. To evaluate a product's aesthetics viewed from every angle.
   b. As an aid in estimating tooling and manufacturing costs.
   c. To check human engineering considerations.
   d. As a final check on clearances and fixed dimensions.
   e. All of these.

9. The methodology used by industrial designers can be essentially the same whether the product being designed is a toy or a power tool.

   a. True b. False.

10. The consideration of the human engineering principle is more important with independent design consultants than with corporate designers.

    a. True b. False

11. Which would be the better way to state a design problem?

    a. Design a series of finger puppets.
    b. Design finger puppets in the form of a dog, cat, and frog.
    c. Design finger puppets in the form of a black dog, a yellow cat, and a green frog.

12. Which would be the better way to state a design problem?

    a. Design a new toothbrush.
    b. Design a vibrating toothbrush.
    c. Design a new way to clean teeth.

13. Which would be the better way to state a design problem?

    a. Design a rocking horse.
    b. Design a rocking toy.
    c. Design a toy.

14. Brainstorming is best described as:

    a. "A bolt from the blue" or a sudden idea.
    b. A meeting where a group of people try to generate ideas.
    c. A meeting where designers are presented to others in the decisionmaking process.
    d. All of these.
    e. None of these.

15. Corporate designers are:

    a. Independent consultants.
    b. Staff designers employed by a company.
    c. An incorporated design firm.
    d. Engineers.

16. When a designer shows his work to management, this meeting is called:

    a. A presentation.
    b. A critique.
    c. An analysis.
    d. A brainstorming session.

17. A brand name may best be described as a name given to:

a. A new product.
b. A product labeled after a company has merged with another company.
c. A specific model of a product within a whole line of products.
d. Products sold to another company in volume sufficient to change the appearance and carry the second company's label.

18. Anthropometry is:

a. Study of body measurements.
b. Hitch-hiking.
c. Brainstorming.
d. Developing a name for a product.

19. In developing a toy, which of the following would the designer be *least* likely to make a decision about?

a. The final cost of the product.
b. The colors of the various parts.
c. Where the name of the company is placed on the toy.
d. Evaluating his own design solutions.

20. A consultant industrial designer usually deals primarily with a company's:

a. Drafting department.
b. Sales department.
c. Advertising department.
d. Middle or upper management.

ANSWERS TO CHAPTER III EVALUATION

1.	B	11.	A
2.	B	12.	C
3.	A	13.	B
4.	B	14.	B
5.	B	15.	B
6.	A	16.	A
7.	C	17.	D
8.	E	18.	A
9.	A	19.	A
10.	B	20.	D

INTRODUCTION TO CHAPTERS IV, V, AND VI

Chapters IV, V, and VI, are related to the methodology used by industrial designers. Some of these methods are described and may be referred to as students perform similiar design activities.

It is recommended that each student select a product to be redesigned or develop an entirely new one. Regardless of which type of project is chosen, it should be developed following the techniques given in these remaining chapters. Additionally, the industrial design activities should be carried out as the instructor deems appropriate to the course goals.

As the students solutions to the problems will primarily be divergent in nature, the evaluations of student performance are left to the instructor's professional judgement.

Chapter IV

THE DESIGN PROBLEM-SOLVING PROCESS

A design problem is a creative problem-solving activity. A creative problem has no single correct answer. The solutions are *divergent* in nature, that is they have *several or many possible alternative solutions.* On the other hand, analytical problems are convergent, or those which have a single, correct, precise solution. By presenting design problems, it is hoped that divergent thinking will be encouraged and that student creativity will in turn be nurtured.

THE STATEMENT OF THE PROBLEM

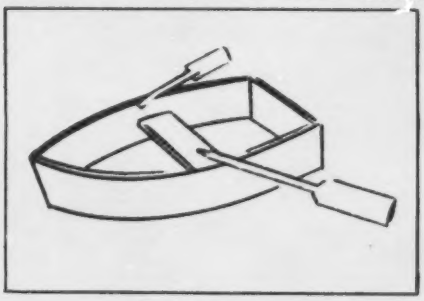


Fig. 4.1

The statement of a problem may seem at first to be a rather unimportant aspect of the design process. This could not be more incorrect. It is perhaps the most important part of encouraging an individual to think. Let's look at a problem that is stated poorly and revise it in order to help stimulate the thinking of solutions. *(Poorly stated):* "Design a boat to cross a small pond". This is stated poorly because it encourages a stereotype solution. Most of us have a preconceived idea, or concept, of what a boat is and the general form it might take. The chances are that students would make a boat pointed at one end, a place to sit, and some sort of paddle for propulsion. *The point is that the solution seems obvious and does not encourage one to think.* The other extreme is almost as bad. If we ask students to "design something", it could make them bewildered or frustrated. This statement is too broad and without direction. The boat problem was stated in terms that were too broad. Should the boat be a small model or one that could transport people? The answer to stating a problem lies somewhere between these two extremes. *The problem should be stated in broad enough terms to avoid stereotype solutions and with some limitations given to assist the students in formulating a variety of solutions.*

ALTERNATIVE STATEMENT OF THE PROBLEM

Design a floatation device which will transport one individual across a pond. The following limitations must be considered:

1. No internal combustion engines may be used for propulsion.
2. A maximum of $5.00 may be spent. Discarded materials can be collected and used.
3. Three weeks will be taken to complete the project.

4. The device must keep the individual safe and dry.
5. The device must be able to be navigated over a given course.

Fig. 4.2 "Hampster Cage" design allows student to walk inside as a means of propulsion.

Fig. 4.3 Student tries to walk on water.

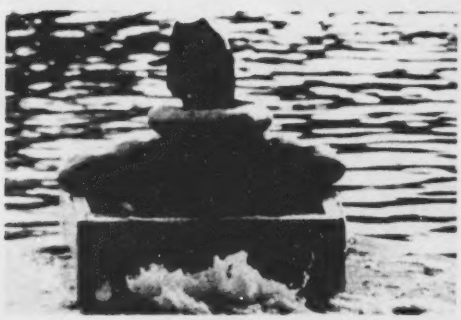


Fig. 4.4 The design limitations disallowed internal combustion engines. This student used an auto starter with a battery as his propulsion. He is sailing along here at approximately 6 M.P.H.

Fig. 4.5 The uniqueness of this design is the use of cardboard to construct the floatation device.

Fig. 4.6 A bicycle wheel, chain, and pedals were the energy source used here. Note tabs attached to wheel for traction.

Fig. 4.7 "Water spider design" . . . Whoops! Water spiders have five legs, not three.

IDEATION

When given a problem, we may consciously and/or subconciously try to solve it. Little research has been done to conclude how our thinking apparatus works to solve problems. Perhaps we all differ in how this takes place. Some of us may try to solve the problem exactly as stated; some may try to redefine the problem by turning it around. Others may try to concentrate on similiar type situations or on problems experienced in the past. Any number of such possibilities exist. We often solve problems with an *intuitive idea or that "spark of genius."*

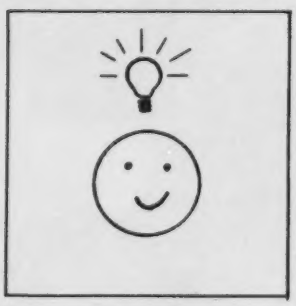


Fig. 4.8

We have seen light bulbs in cartoons indicating the flash of an idea. In advertisements we see how **"FORD"** has a better idea illustrated by substituting a lightbulb for the letter "O". How intuitive ideas happen may remain a mystery for some time. However, it is important because many problems are solved that way. A clear limitation in solving problems by intuition is that it is somewhat haphazard. A more desirable method is to systematically inspire ideas.

INDUSTRIAL DESIGN ACTIVITY

SPLASH MACHINE

General Problem:

Design a machine which will splash water from an open area such as a lake or pond to a distance of thirty feet. The water must be sufficiently directed to put out a candle. The candle flame will be 10" above the water.

Limitations

1. A maximum of $3.00 can be spent.
2. The designer cannot jump into the water, or use any part of his or her body to directly splash.
3. There must be at least one change in direction of energy. (Cannot use an item like a golf club; it must have at least one linkage.)
4. All devices must be transported to the splashing site, and all debris must be removed at the conclusion of the problem by each student.

A BRAINSTORMING SESSION

A brainstorming session is an informal conference for the sole purpose of producing a large quantity of ideas which can serve as leads to problem solutions; they can *be evaluated and processed later.* One person is designated as the leader; another is a secretary to record ideas. The leader has the responsibility to see that certain rules are followed.

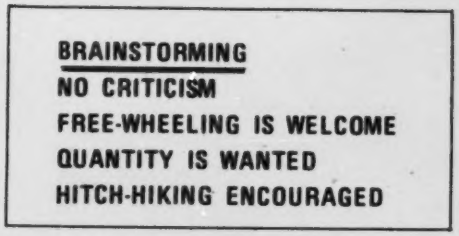


Fig. 4.9

In a brainstorming session, one extremely important rule is to *disallow criticism.* Any adverse judgement must be withheld. Group brainstorming gives *reinforcement* by rewarding all suggestions with receptiveness. Remember, judgement or evaluation of the ideas will come at a later time.

Free-wheeling, or wild ideas, are welcome. *Quantity* is the ultimate goal. With a greater number of ideas, there is more likelihood of finding useful ones. *Hitch-hiking,* or building on someone else's idea, is encouraged. One idea will stimulate another. Hitch-hiking is the building of one idea on another. During a brainstorming session, a person who wants to hitch-hike snaps his or her fingers. The leader then knows to call on that individual next. Remember, the ultimate goal is to come up with as many solutions as possible. In a brainstorming session lasting several hours, a group can generate literally hundreds of ideas.

If the group slows down, the leader may redirect the discussion. For instance, if the topic you are brainstorming is "different uses for cinder blocks", some typical statements may be door stops, concrete filler, water purifications, etc. If the ideas seem to slow down, the leader may ask any number of questions such as, "How about uses in the food industry?", or "What could the military use cinder blocks for?", "How about household products?", "How could we change their form and then use the new material?, etc.

Topics

The topic may be stated in terms of a specific problem. For example, "We are a manufacturer of cinder blocks. Another company has developed a product to replace the cinder blocks. What uses are there for ½ million blocks which we have stockpiled?"

The problem may be given in a more brief statement such as, "Different uses for cinder blocks."

A few other possible topics are: uses for wood dowels; how car weight can be reduced; uses for old tires; utilization for bark from tress; different ways to support a vehicle; ways to transport bulk material across the ocean; uses for wooden clothespins; new topics for a brainstorming session; new uses for discarded products; etc.

INDUSTRIAL DESIGN ACTIVITY

CLASSROOM BRAINSTORMING ACTIVITY

1. The Group and the leader – The teacher may act as the leader in the first brainstorming session. The class can later break into groups to conduct separate sessions. A group of 5–8 students is ideal. At first limit the discussion to about 10-15 minutes unless the ideas are still flowing fluently.
2. Recording ideas – Designate an individual to be the secretary to record the ideas. The ideas may flow quickly, therefore one word or perhaps a few words may be recorded for later reference. (Perhaps a tape recorder can be used in addition to but not in place of a secretary.)
3. Review the rules:
   a. No criticism of any idea.
   b. Free-wheeling is welcome.
   c. Quantity is wanted.
   d. Hitch-hiking is encouraged.
4. Select a topic.
5. Adjust the length of each session as required.
6. In a fifteen minute period, perhaps as many as fifty ideas may come forth. The teacher can be the judge of the success of the session.

THE TEAGUE APPROACH

Walter Dorwin Teague Jr. has developed a formal approach toward evaluating design solutions through a systems analysis. It is actually a simplified version of what a computer would do when selecting from several design options.

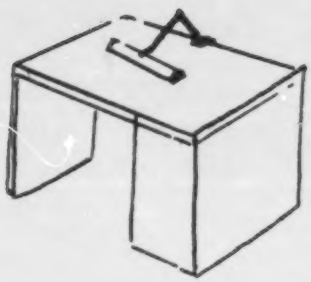
First, list the design objectives and rate each objective on a scale of 1 to 10 depending on its importance. Ten indicates most important, and one indicates least important. For instance, several design objectives and an indication of the degree of importance to each are given as follows:

1. The product should be mobile enough to be moved from one room to another. (In this case this design objective may be very important, therefore it is rated 9.)
2. The product should have an optional light source. (This design objective may not be very important, therefore it is rated 3.)
3. The product should have an auxiliary energy source in case of a power failure. (This design objective may be somewhat important, perhaps it is rated 5.)
4. The product should have some type of protective cover. (This may be a relatively important consideration and is rated 7.)

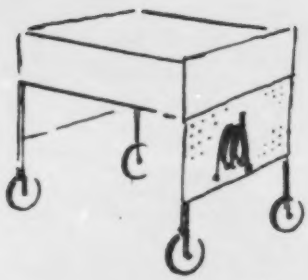
DESIGN OBJECTIVE	Rating			
1. Mobile enough to be moved from one room to another	9			
2. Optional light source	3			
3. Auxiliary Energy source	5			
4. Protective Cover	7			
TOTALS				

Fig. 4.10

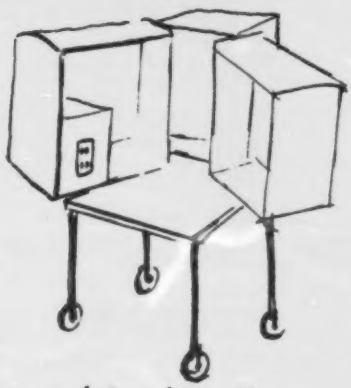
Then the alternative design solutions are evaluated with each solution considered against each objective. This is also rated on a scale of 1 – 10 depending on how well the design solution satisfies each design objective. The higher number is given to the better solutions. These are then placed in a matrix and multiplied. The design solution with the highest number of points is presumably the best design.



design solution #1



design solution #2



design solution #3

Fig. 4.11

DESIGN OBJECTIVE	Rating	Design Solution 1	Design Solution 2	Design Solution 3
1. Mobile enough to be moved from one room to another	9	Not very mobile rated 2 (9x2) = 18	Very mobile rated 10 (9x10) = 90	Very mobile rated 9 (9x9) = 81
2. Optional light source	3	Excellent rated 10 (3x10) = 30	Poor rated 2 (3x2) = 6	Excellent rated 10 (3x10) = 30
3. Auxiliary Energy source	5	None rated 1 (5x1) = 5	Good rated 8 (5x8) = 40	Excellent (5x10) = 50
4. Protective Cover	7	Fair rated 5 (7x5) = 35	Very good rated 8 (7x8) = 56	Very good rated 8 (7x8) = 56
TOTALS		89	192	217

Fig. 4.12

Utilizing the Teague approach, the best design solution would be Design Alternative No. 3 with a total of 217 points. In most cases ten to twenty objectives would be used, however the procedure would be the same. An important point is that the design objective should be determined prior to the design solution stage. The designer should first know what to design before beginning the process.

INDUSTRIAL DESIGN ACTIVITY

THE TEAGUE APPROACH

1. Establish one or more design teams of seven or eight students each. Utilizing the Teague approach, determine a set of approximately ten design objectives for a golf cart.
2. Next, each member of the design team rates each objective on a scale of 1 – 10 depending on its importance. The same numerical rating may be given to more than one objective.
3. Average each member's numerical values to determine the rating for each objective.

	DESIGN OBJECTIVES	Rating	Design A	Design B	Design C
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

4. a. Refer to the golf cart design alternatives shown in Fig. 4.13.
   b. Each student considers each design alternative against each objective and rates each on a scale of 1 – 10.
   c. Place the average score of the students ratings for each design solution in relationship to each design objective in the appropriate column.
   d. Total the score in each column to determine which golf cart is the best solution to meet *your* criteria.

design solution #1

design solution #2

design solution #3

Fig. 4.13

Chapter V

VISUAL COMMUNICATIONS

Visual communications is important in the design process. It is the designers way to let others know what he or she is thinking. In the first stages of a product's design, rough sketching is a common practice. The designers search for a direction or possible solutions to the problem. The designers make judgements, combine ideas, and then work up refined or finished sketches which are presented to the client. After the design direction has been fairly well established, a rendering may be prepared. These methods are described in the following text.

SKETCHING

Sketching, or rough visualization, of ideas is an important step in product development. Although designers work with models or mock-ups, this is slow and costly. Sketching is not simply a means of communication; it is a working tool as indispensible as the architect's plan. On a two-dimensional surface, designers create an accurate illusion of a three-dimensional object. There is no standard approach to sketching, and techniques may vary almost as much as handwriting. Some designers work very small with what are called 'thumbnail' sketches, while others work large. Some work light; others work dark with contrasting values. Some work loose, smudging broad areas with their fingers; others use straight edges and other aids. The essential thing is that sketching should become easy and natural and not interfere with your mental idea.

Any type of pen or pencil may be used for sketching. Felt-tip pens are excellent for this purpose; they produce a soft tone or a very rich black. The ink dries instantly and doesn't smear. The designer should "think with his pencil" in the form of doodles. It is very difficult to sit and try to think of a design solution.

When sketching, work the large areas first, leaving the details until last. Many ideas emerge spontaneously from sketching. Sketching should be done on only one side of the paper in order to compare the results easily. The designs should then be criticized; select and refine the better ideas.

SKETCHING IN PERSPECTIVE

Perspective may be described as a systematic distortion of an object. For instance, the optical illusion that railroad tracks converge into a single point at a distance is a common example of perspective.

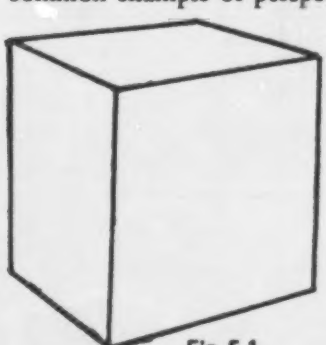


Fig. 5.1

Using the cube as an exercise in freehand sketching will enable us to learn the fundamentals of simple, two-point perspective. Keep in mind proper proportions. Each side of the cube should *appear* to be equal.

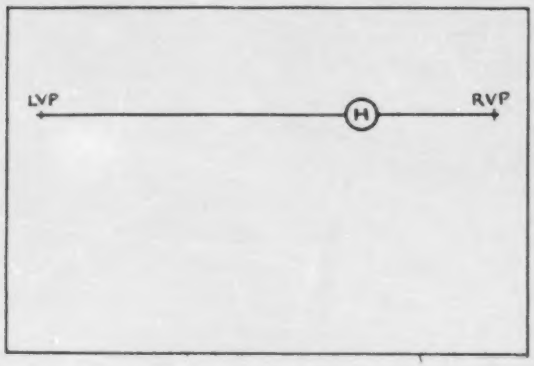


Fig. 5.2

Begin by drawing a horizontal line, (H), freehand across a plain piece of white paper. (Fig. 5.2) Approximately ¾" from each edge, draw LVP (left vanishing point) and RVP (right vanishing point). Be sure that the horizon line is *not tilted,* but horizontal on the paper. The location of the cube, or object being drawn, may be anywhere; however it is generally a good practice to keep the object within a radius from the mid-point between the two vanishing points. (Fig. 5.3)

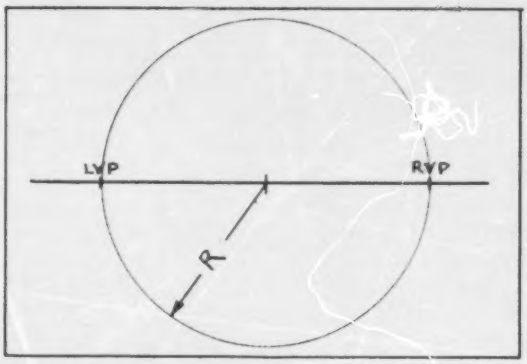


Fig. 5.3

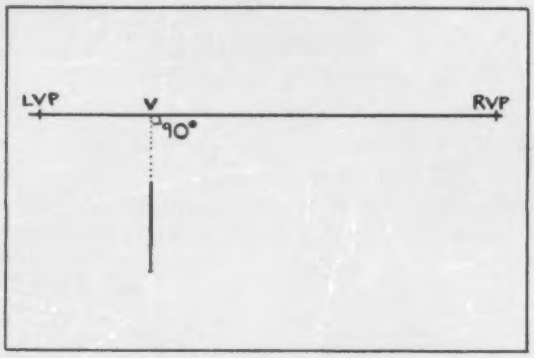


Fig. 5.4

Begin by dropping a vertical line (V) perpendicular to the horizon line. (Fig. 5.4) This will be the front edge of the cube. From the top and bottom corners, draw construction lines to LVP and RVP. (Fig. 5.5) Next estimate the width and depth of the cube and draw two vertical lines representing these corners. (Fig. 5.6)

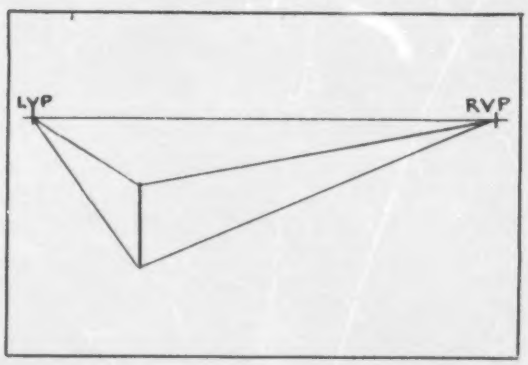


Fig. 5.5

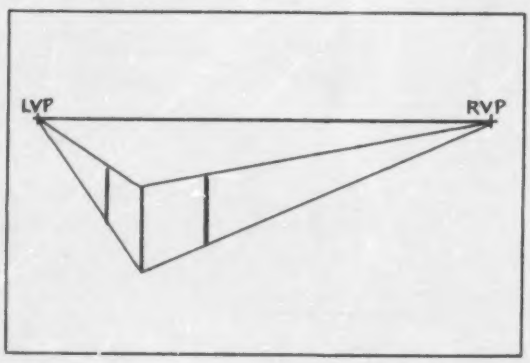


Fig. 5.6

From the top left corners, connect a line to RVP; and from the top right corner, connect a line to LVP.(Fig. 5.7) Next, darken the cube as illustrated in Fig. 5.8.

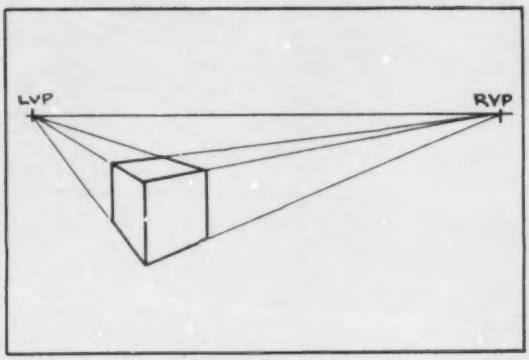


Fig. 5.7

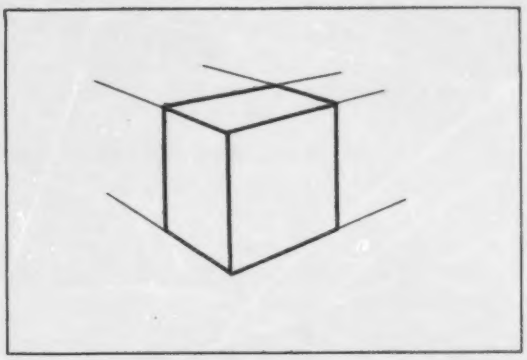


Fig. 5.8

The students may then draw several cubes above, below, and touching the horizon line. Since the horizon is located at normal eye level, the cubes shown above the horizon will show the bottom (Fig. 5.9); the cubes which will be coincided with the horizon line will not show either the top or the bottom. (Fig. 5.9)

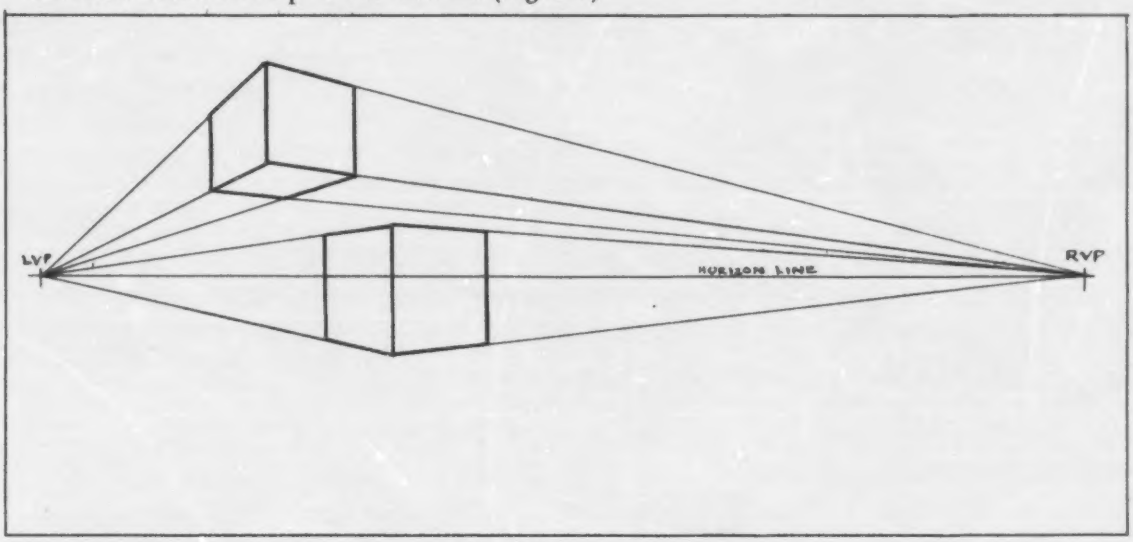


Fig. 5.9

The cubes in various relationships to the horizon line are shown in Fig. 5.10. This exercise is given in the student manual. In order to assist the instructor when criticizing student work, the following common errors are discussed.

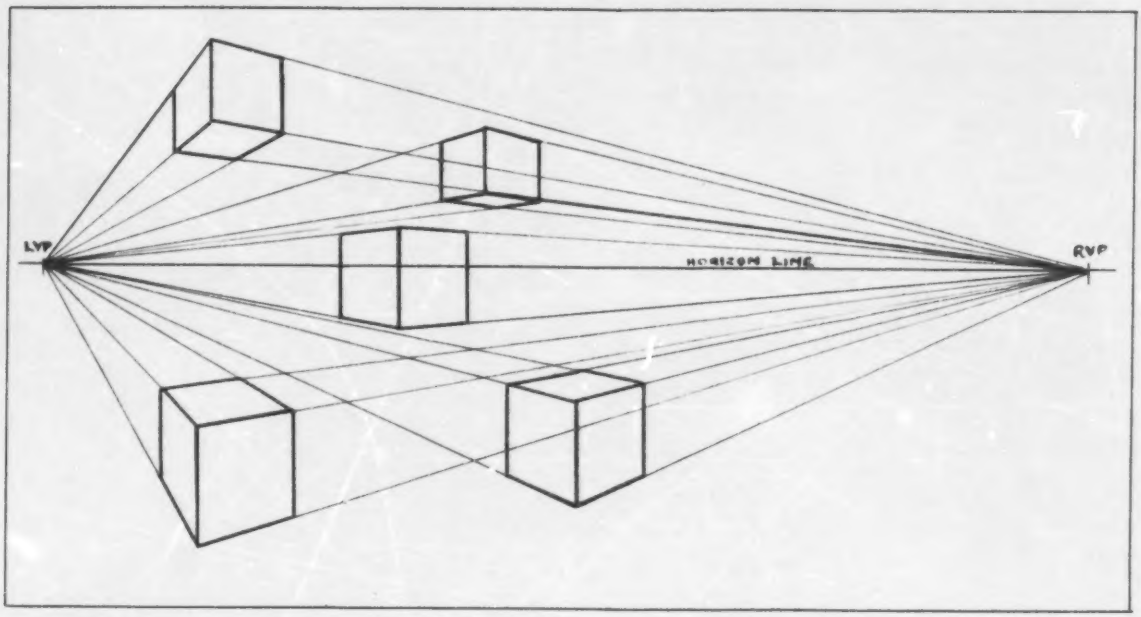


Fig. 5.10

INCORRECT PROPORTION

The top, front, and sides should appear to be equal in size. In Fig. 5.11, the object appears to be long and thin. The sides of the cubes should look equal as those illustrated in Fig. 5.10.

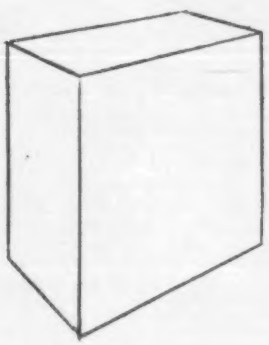
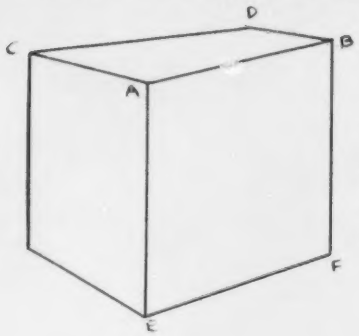


Fig. 5.11

INDUSTRIAL DESIGN ACTIVITY

Draw five cubes on the page below – two cubes below the horizon line, two cubes above the horizon line, and one on the horizon line.

IMPROPER CONVERGENCE TO VANISHING POINTS



All parallel lines must converge to the same vanishing point. Line CD and EF converge at RVP. If AB were extended, it should also converge at RVP. Since the dotted line, representing the extension of AB (Fig. 5.12) does not converge at RVP, it is incorrect.

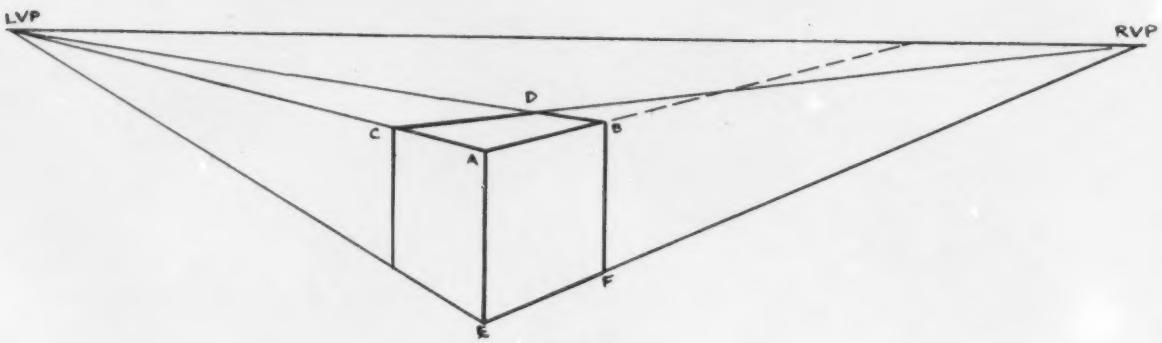


Fig. 5.12

TILTED HORIZON LINE

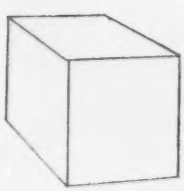


Fig. 5.13

If we would extend the paralled sides of Fig. 5.13 to the vanishing points and then draw a horizon line through these vanishing points, the horizon line should be horizontal. This error is illustrated in Fig. 5.14. Another rule is that the vertical lines must be 90°, or perpendicular, to the horizon line. The broken line, representing the front corner of the cube, when extended to the horizon line, is *not* intersecting at a right angle.

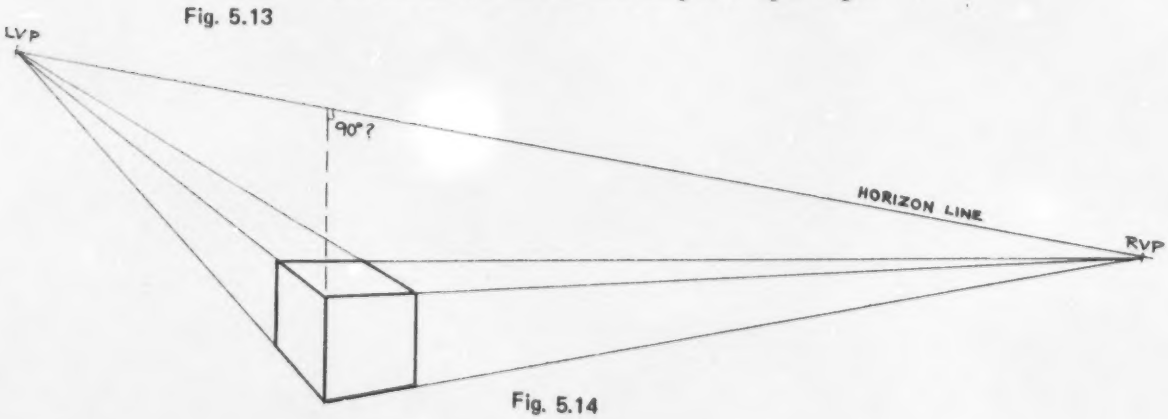


Fig. 5.14

VISUAL DISTORTION

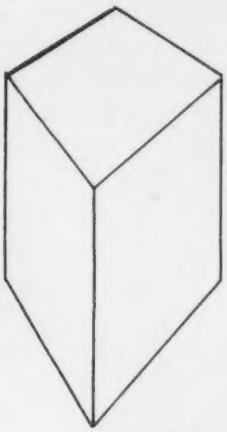


Fig. 5.15

The cube illustrated in Fig. 5.15 may be drawn correctly, however it appears to be distorted. If the sides were extended, they might meet the vanishing points correctly and the horizon line might be horizontal. The error is that this object is drawn outside of the circle of acceptability. (Fig. 5.3) A general rule to remember is that the front angle A in Fig. 5.16 should always be 90° or larger.

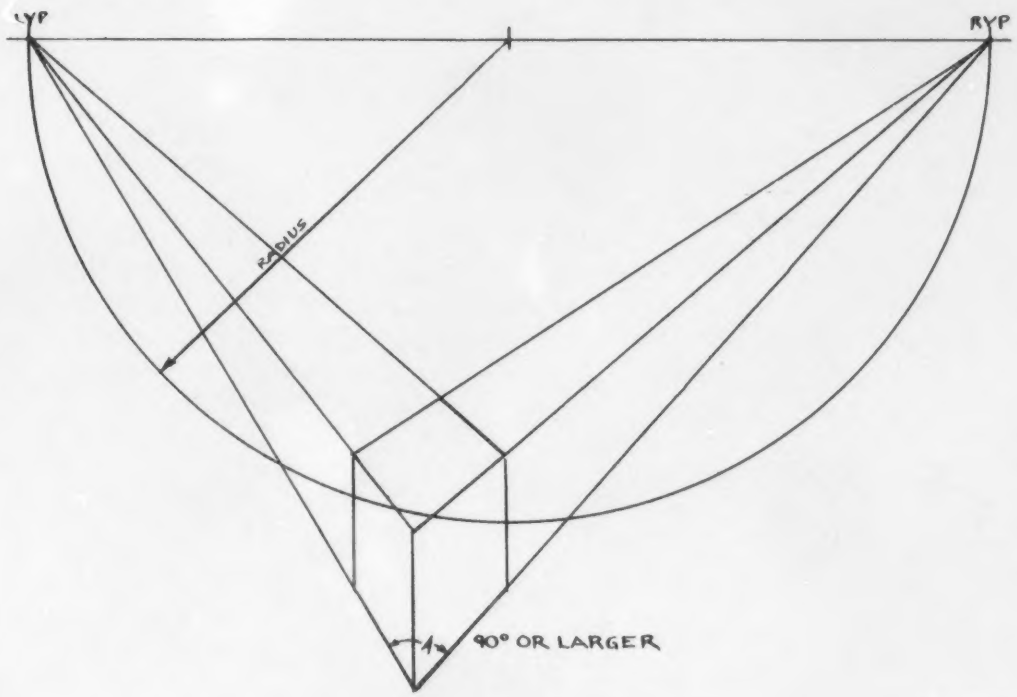
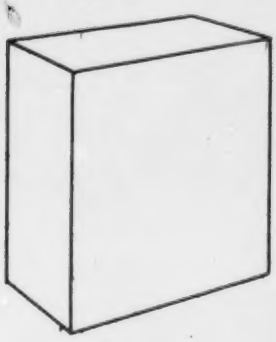


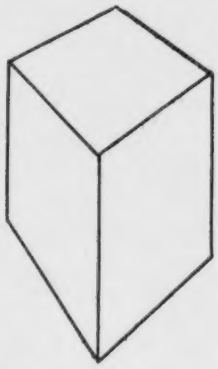
Fig. 5.16

INDUSTRIAL DESIGN ACTIVITY

Critique the following cubes as correct or incorrect. Why is each cube correct or incorrect?



1. OUT OF PROPORTION



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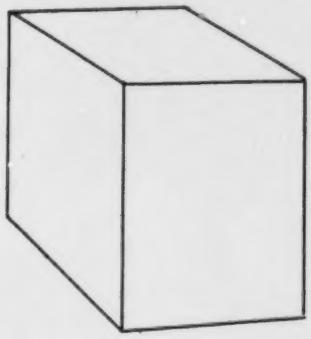
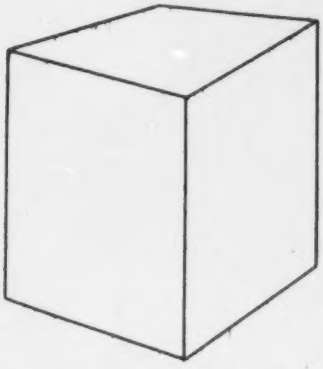
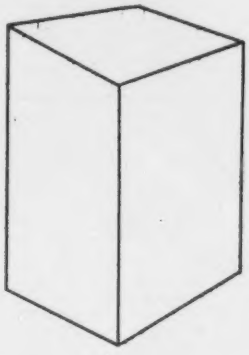


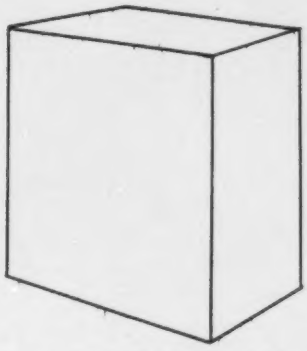
3. TILTED HORIZON



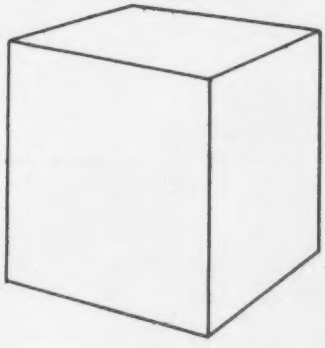
4. IMPROPER CONVERGENCE



5. IMPROPER CONVERGENCE

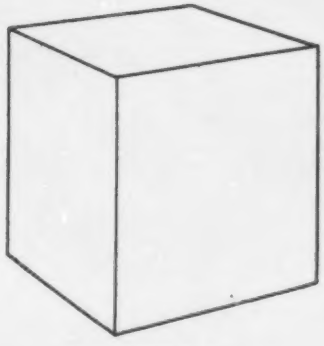


6. OUT OF PROPORTION



7. CORRECT

8. VISUAL DISTORTION



9. CORRECT

SKETCHING OTHER SHAPES

The Ellipse

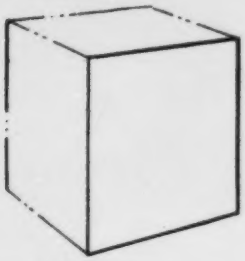


Fig. 5.17

The ellipse is a circle in perspective. When sketching the ellipse, one may begin by first drawing a square or one side of a cube, in perspective. The solid lines in Fig. 5.17 are the only lines necessary. The phantom lines are merely for reference. After this plane is constructed (Fig. 5.18-a), draw two diagonal lines from the corners of the square to locate the center.

Draw two lines through the center, one perpendicular and one parallel to the top and bottom. This parallel line would meet at the vanishing point if extended. Draw a short curved line through each end of these lines (c). Then, connect the curved lines to complete the ellipse (d).

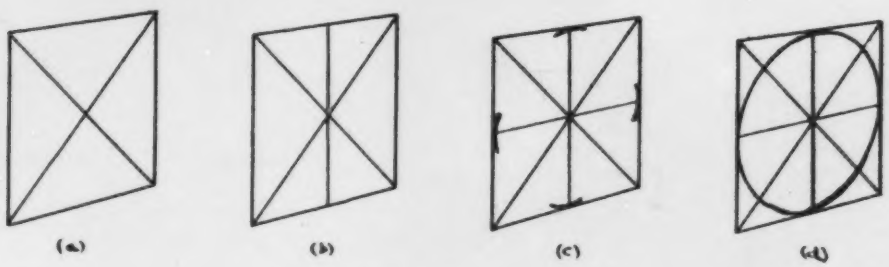


Fig. 5.18

Utilizing the cube and the ellipse, the cylinder and cone can easily be sketched.

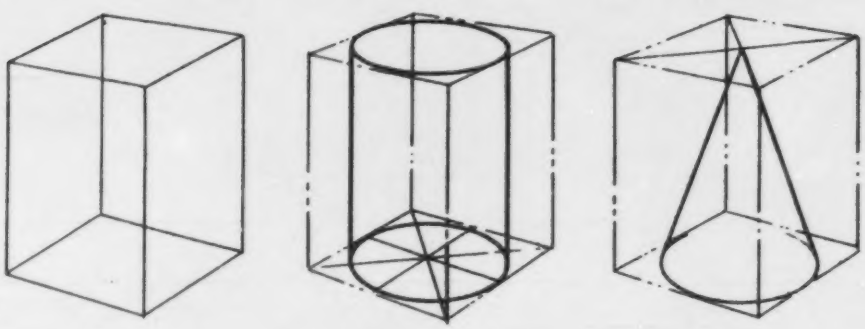


Fig. 5.19

When sketching, an individual may begin by first constructing the basic forms and then expanding on these as desired. (Fig. 5.20)

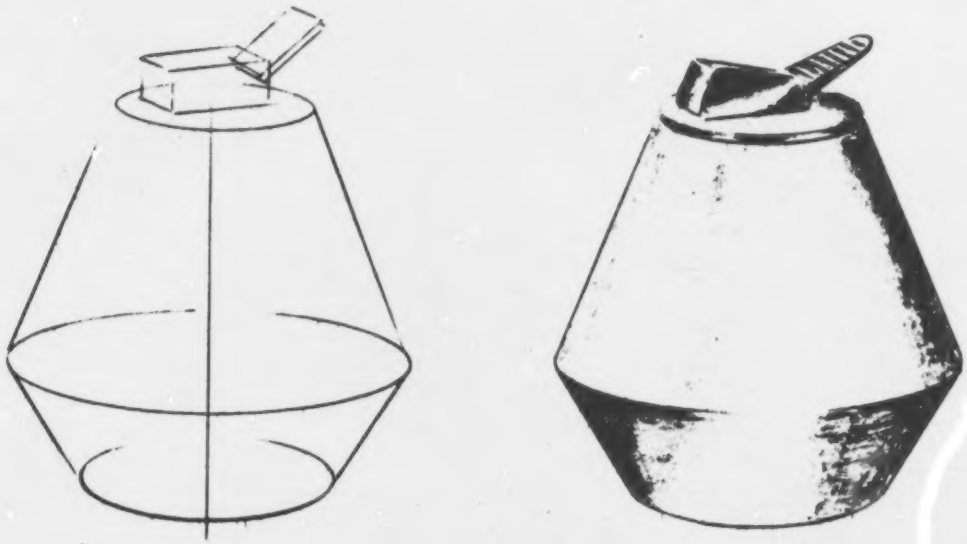


Fig. 5.20

INDUSTRIAL DESIGN ACTIVITY

Sketch the basic forms of the cube, cone, and cylinder.

RENDERING

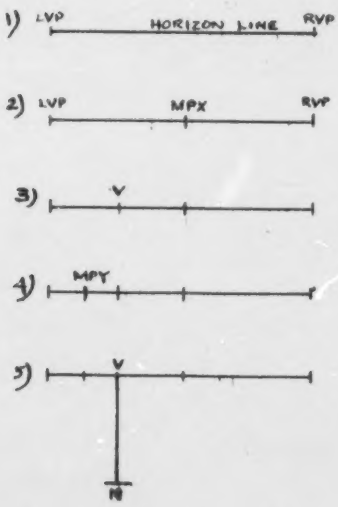
A rendering is a carefully finished drawing of what the product will look like when produced or constructed. It shows the design conception, complete in every detail, from a direction which best describes the product. The purpose of making a rendering is to illustrate the finished product. It is a point in the product-making process where design changes can still be made without excessive costs to the manufacturer. Design changes are least expensive in the sketching and rendering stages. These costs become much more expensive in the model-making stage, and should be totally avoided while in production.

Before beginning the rendering, the designer must decide the best view, the scale, and the size of the rendering. A good line drawing in perspective should be prepared on tracing paper which can later be transferred onto the finished illustration board or other similar material. This may be done by rubbing graphite onto the back of the line drawing, taping the line drawing onto the board, and then tracing over it. The graphite acts as a carbon. The rendering may be black and white or in color, using any one or combination of techniques.

THE LINE DRAWING

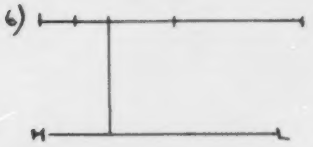
Making a line drawing in perspective is the easiest way to begin the rendering for the industrial arts students. Similar techniques to those used in technical illustration or pictorial drawing in advanced drafting may be applied to the line drawing. The most significant difference is the method of perspective used instead of isometric, oblique, or orthographic projections.

Many perspective methods require a plan view in order to construct a perspective drawing. There is one method which does not require a plan view. We must know the dimensions of the ojbect that we are drawing. For instance, let's take a cube 3" x 3" x 3". We would begin as follows;

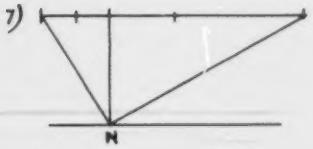


1. Draw a horizon and establish the two vanishing points LVP and RVP.
2. Bisect the distance between the vanishing points to locate the measuring point MP–X.
3. Bisect the distance between MP–X and LVP to locate V.
4. Bisect the distance between V and LVP to locate the measuring point MP–Y.
5. Draw a vertical at V and place nearest angle N of the cube at the desired distance above or below eye level.

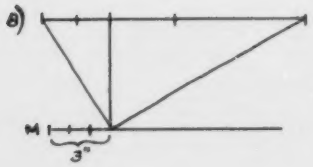
Fig. 5.21 (cont.)



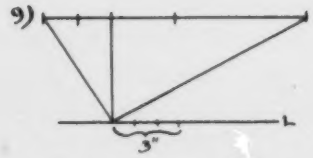
6. Draw a horizontal measuring line ML through N.



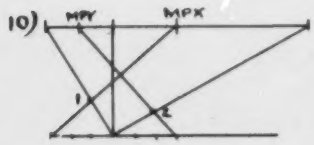
7. Draw perspective lines from N to LVP and RVP to construct the nearest angle or bottom edges to the cube.



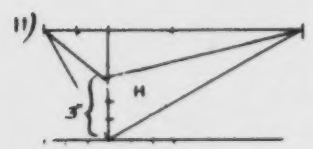
8. Measure the depth of the object from point N toward M to establish point X. In this case measure "3".



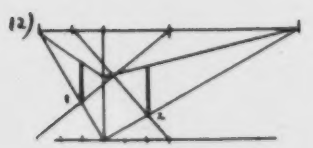
9. Measure the width of the object from point N toward L to establish point Y. Again measure "3".



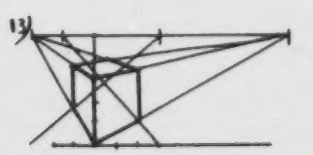
10. Draw a line from X to MPX and note its intersection with the perspective line at 1. Repeat for MPY and MPV locating 2.



11. Measure the height from point N to establish H (3"). Connect H to the vanishing points.



12. Draw vertical lines from points 1 and 2.



13. Connect the top corners of the cube to the vanishing points and darken the object.

Fig. 5.21

INDUSTRIAL DESIGN ACTIVITY

Draw a block in 30° – 60° perspective. The dimensions are 2″ deep, 3″ wide, and 1″ high. Use only a straight edge and pencil; label all marks.

If the object had different dimensions, i.e., 9" deep, 4" wide, and 5" high, then we would substitute 9" for 3" in Step 8, 4" for 3" in Step 9, and 5" for 3" in Step 11. for

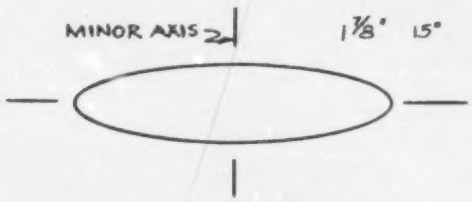


Fig. 5.22

If a hole appears in the object, it is best to use ellipse templates to simulate it. Ellipse templates range from 10° through 80° in 5° increments. Each has several markings as shown in Fig. 5.22. The 1 7/8", dimension refers to the widest part of the ellipse. The minor axis lines are the important references in perspective drawing. The minor axis of the ellipse is extended from the opposite vanishing point to the surface on which it is drawn. (Fig. 5.23) Ellipses on the top surface are drawn with the minor axis vertical to the horizon line. (Fig. 5.23)

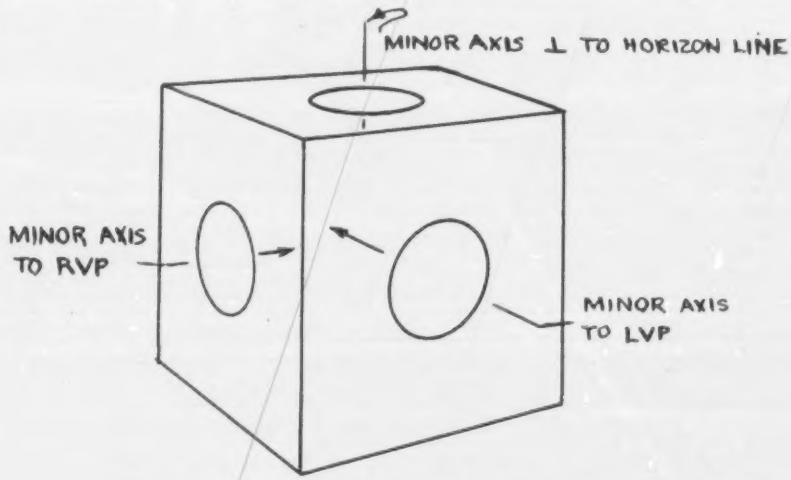


Fig. 5.23

Figure 5.24 shows a correct and incorrect ellipse on two cubes. Note how tilted the hole looks on a, while the hole on the cube marked b looks proper.

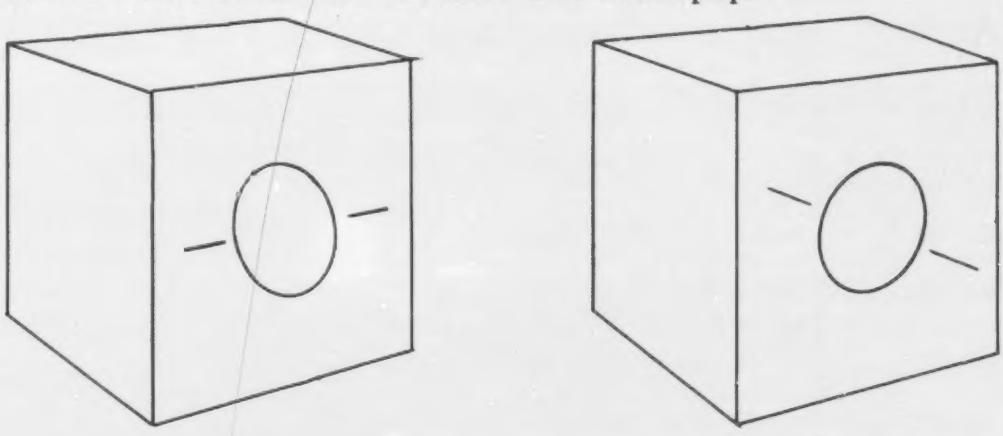


Fig. 5.24

The cube in Fig. 5.25-a shows approximately equal amounts of surface area on each side. These would then use a 45° ellipse template. If a cube were drawn showing approximately 1/3 of one side and 2/3 of the other side, a 30° template would be used on the narrow side and 60° on the wider side.(Fig. 5.25-b)

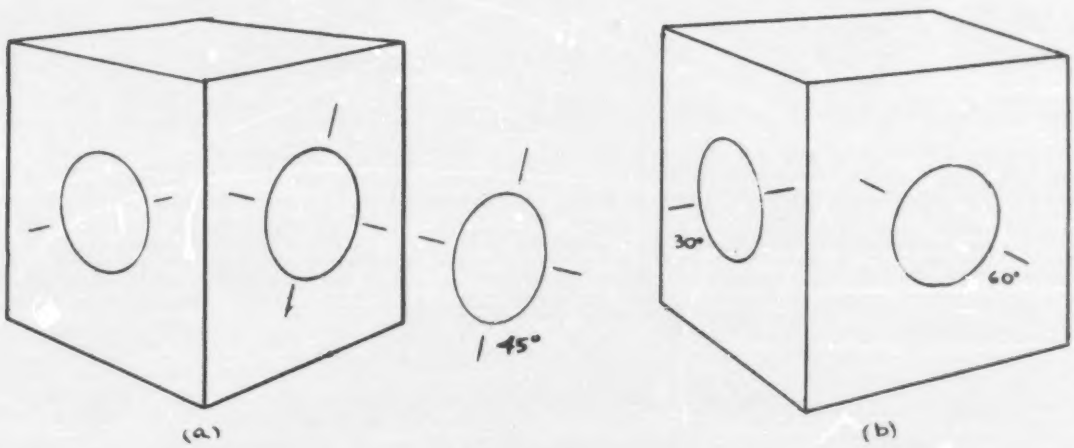


Fig. 5.25

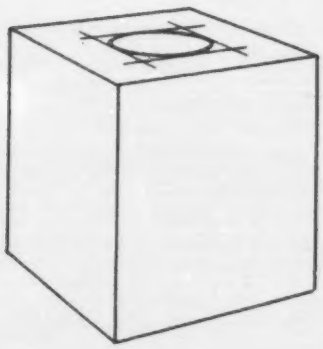
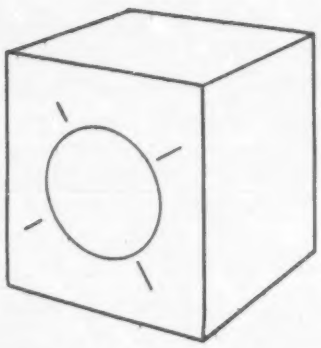


Fig. 5.26

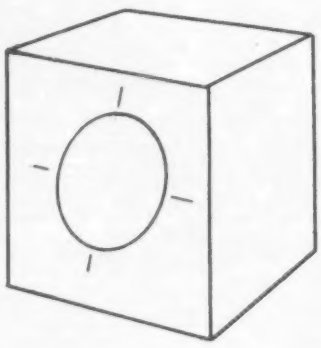
Ellipses drawn on the top surface can be estimated for what appears best. Consider the distance above or below the horizon line and select the template which seems most appropriate. A rendering is an artistic endeavor, and one can make an aesthetic judgement at this point. If this is perhaps uncomfortable, the designer can construct a rectangle and select the ellipse which best touches each side. (Fig. 5.26)

INDUSTRIAL DESIGN ACTIVITY

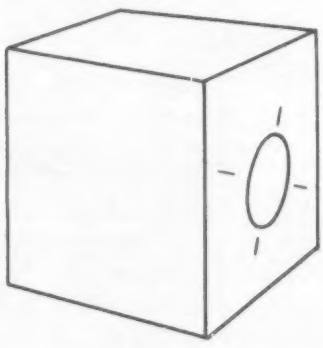
Critique the following ellipses, correct or incorrect? Why?



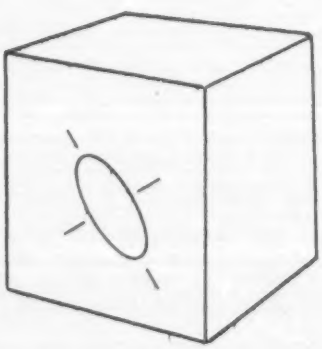
1. CORRECT



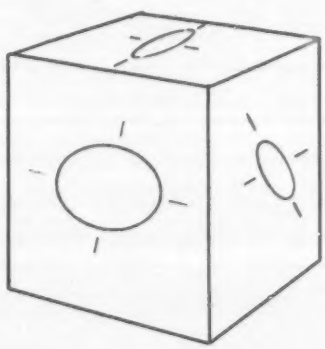
2. INCORRECT



3. CORRECT



4. INCORRECT



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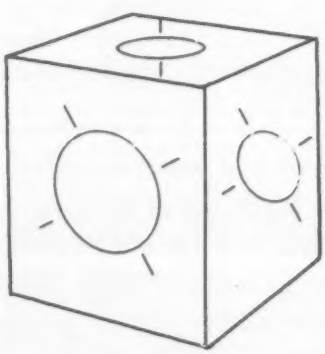
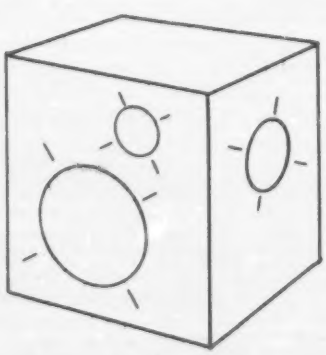
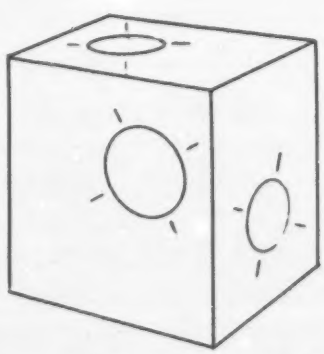


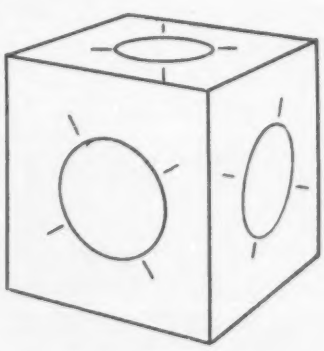
6. INCORRECT



7. CORRECT



8. CORRECT



9. CORRECT

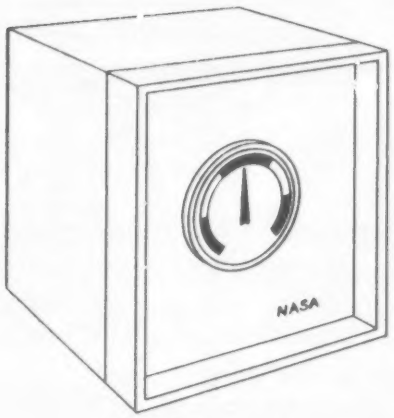


Fig. 5.27

The color rendering phase of product development is usually the most difficult for students to accomplish. In courses such as technical drawing, industrial design, architecture, and various art courses, the instructor may wish to utilize rendering to achieve various objectives. The use of color can add a great deal of interest to what might otherwise be a rather dull drawing. A simple line drawing in pencil or ink often appears somewhat uninteresting.

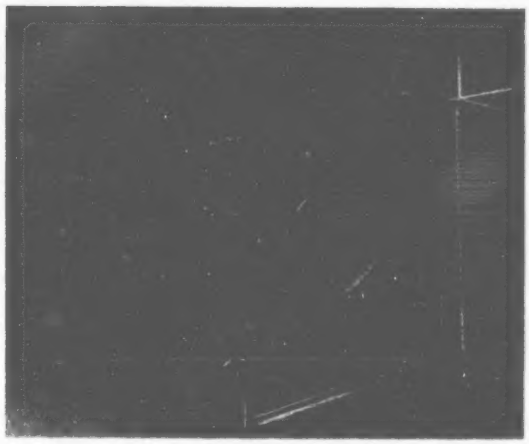


Fig. 5.28

This same drawing may become much more interesting by preparing the line drawing with colored pencils on a black or colored background.

The amount of color and the degree of sophistication of the medium used in rendering can range from making the line drawing in color to finished airbrush renderings.

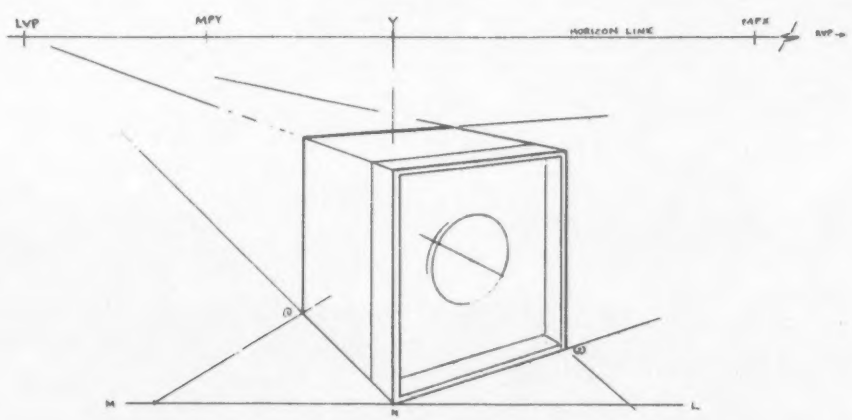


Fig. 5.29

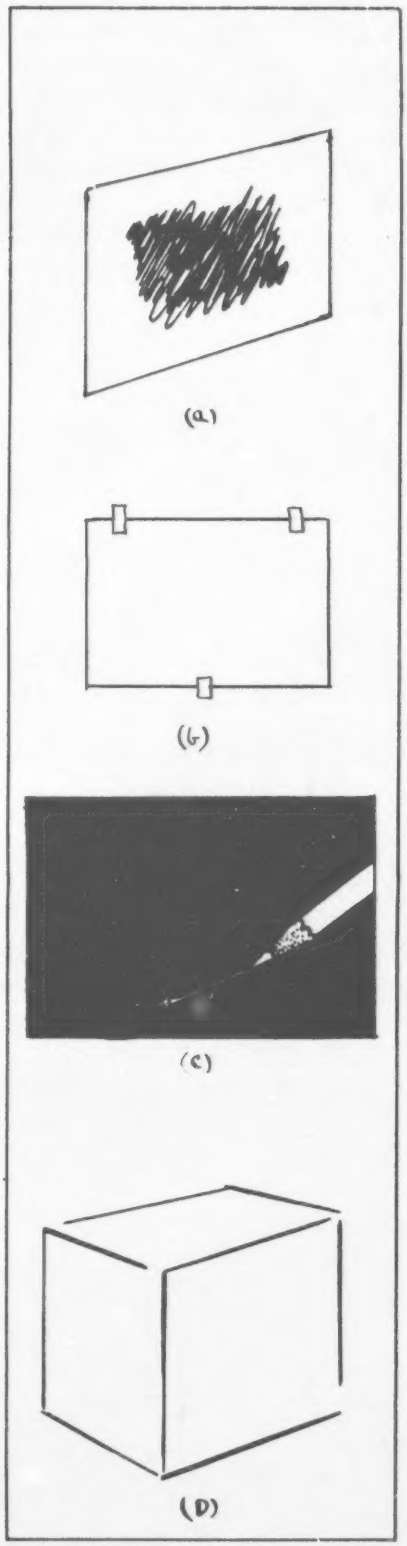


Fig. 5.30

Taking a step-by-step procedure to accomplish the rendering in Fig. 5.28 could be as follows:

Draw the object in two point perspective on a piece of tracing paper or vellum. (Fig. 5.29) Refer to Fig. 5.21.

Reproduce one or two copies of the drawing on blue-line paper or on a xerox-type machine.

If no facilities are available, the student may continue with the original tracing.

Rub the back of one of the prints with a common No. 2 pencil. (Fig. 5.30-a) Take a tissue and rub lightly over the penciled area to remove excess graphite. If the finished rendering will be done on black or very dark paper, rub chalk on the back instead of the pencil.

Tape the print onto the illustrated board or colored paper and trace the entire drawing. (Fig. 5.30-b) Note the position of the tape. The top pieces can serve as hinges which allows lifting the drawing, checking the lines, and replacing in the exact original position if some lines were missed.

A light outline will appear on the paper which will serve as a guide for the finished work. (Fig. 5.30-c) Outline the entire drawing in white pencil.

Next to the white lines, the student can use a black pencil and accent some aspects of the drawing as needed. (Fig. 5.30-d) Don't outline the entire drawing; it will take away interest.

Fig. 5.31

The student may practice making a dark line which will taper off to almost nothing. (Fig. 5.31) These can be used on intersecting lines, darker areas, or almost anywhere the student wishes.

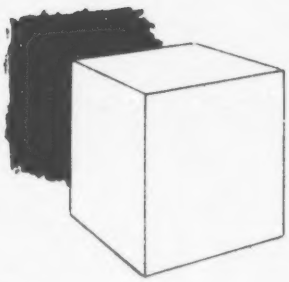


Fig. 5.32

Pastels may be used in combination with colored pencils for effect. An area behind the product may be colored to emphasize the shape or the object itself may be colored. (Fig. 5.32)

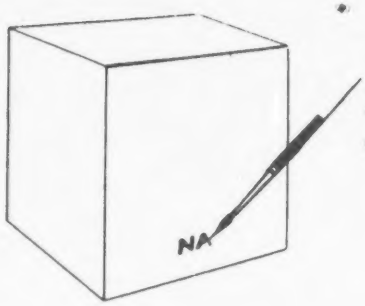


Fig. 5.33

Opaque watercolors, such as tempera, may be utilized for names, trademarks, or to help highlight certain areas. A "000" brush is most ideal.

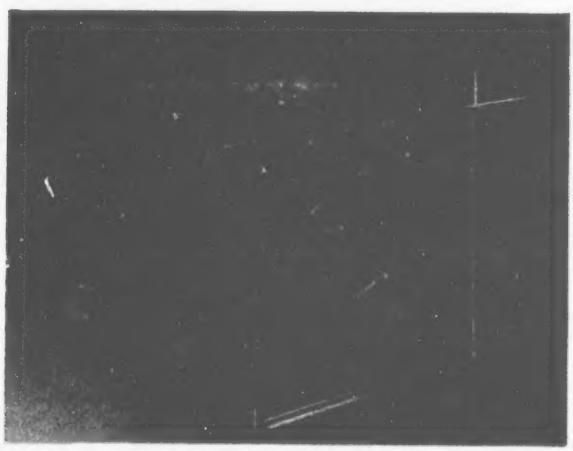


Fig. 5.34

INDUSTRIAL DESIGN ACTIVITY

Sketch a rectangular object with a hole in one plane.

A PASTEL TECHNIQUE

This technique is often referred to as "the smooch technique." This is done by rubbing a piece of graphite or pastel stick on a sanding block and placing the particle on a piece of paper. A cotton swab is then dipped into the fine powder and rubbed in the desired areas. An edge of a piece of paper may be used as a mask. Place the straight edge of the scrap paper against the line to represent the colored area, and begin by applying the pastel to the making paper and rubbing onto the rendering.

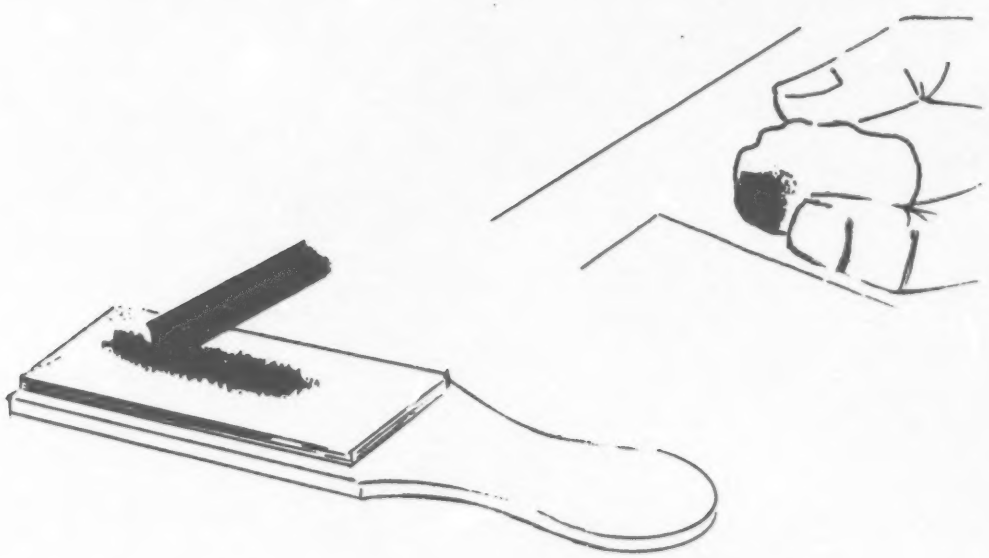


Fig. 5.35

The edge of the pastel stick may be used where a darker line or area is desired. Highlights may be achieved by removing the pastel with a kneaded eraser. The pastel technique may be used directly on the tracing paper. Colored areas may be applied on the back of the tracing. Highlights may be applied with a soft, white pastel on the front of the tracing.

Pastels should be fixed with a clear fixatif such as Krylon Workable Fixatif. This comes in an aerosol can and is applied by holding the can approximately 12" from the drawing and spraying with a stroking motion.

TEMPERA RENDERINGS

Tempera renderings can be carried out to a high degree of completion. Architectural renderings are usually done in this medium. Tempera, an opaque watercolor, can be used in ruling pens for crisp outlines; one color can be laid over another after the first coat is dry. To lay down an even wash or a large area of tempera, begin by applying the desired area of color with clear water. Before the paper absorbs all of the water, the surface will appear to have a sheen. At this time apply the tempera which will flow into the wet area, giving a reasonably even color. This area will not be nearly as even as an airbrushed section or a colored paper inlay, but it can be very effective.

The colored paper overlay is used to give large flat areas of color. This is done by using the original line drawing with the graphite on the back and tracing the desired color section onto the colored paper. This section is then cut out of the colored paper with a sharp X-acto knife and pasted into place. (Fig. 5.36)

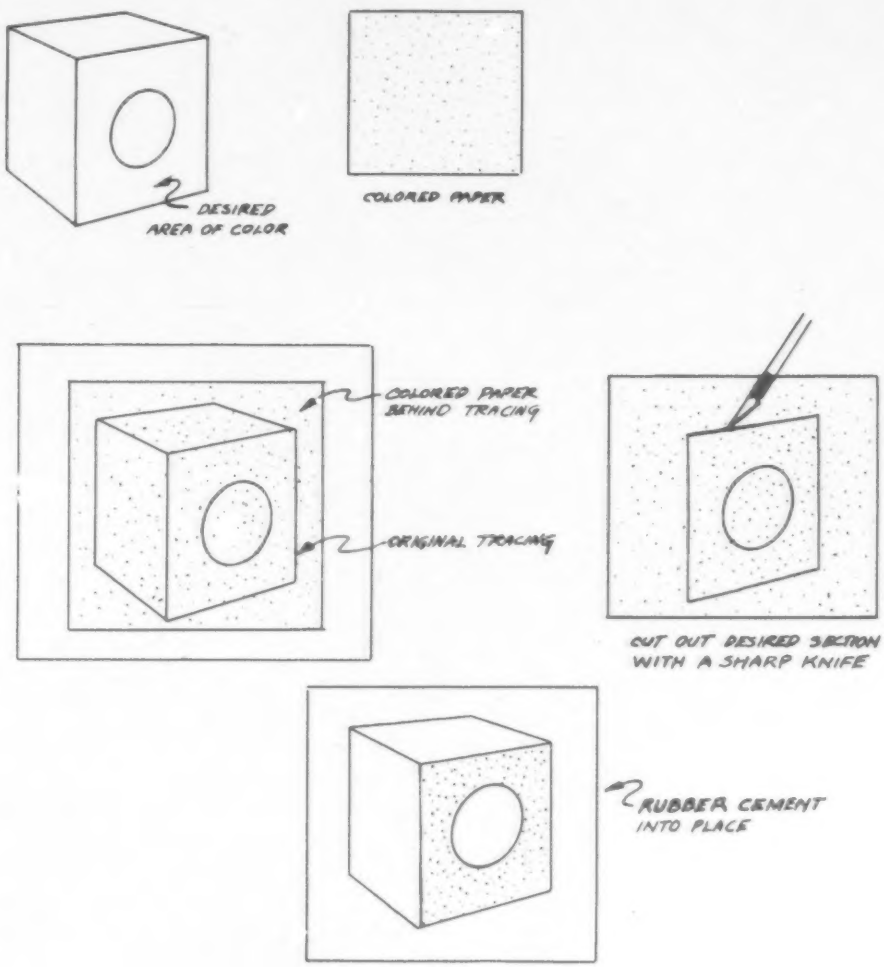

DESIRED AREA OF COLOR
COLORED PAPER
COLORED PAPER BEHIND TRACING
ORIGINAL TRACING
CUT OUT DESIRED SECTION WITH A SHARP KNIFE
RUBBER CEMENT INTO PLACE

Fig. 5.36

RUBBER CEMENT TECHNIQUE

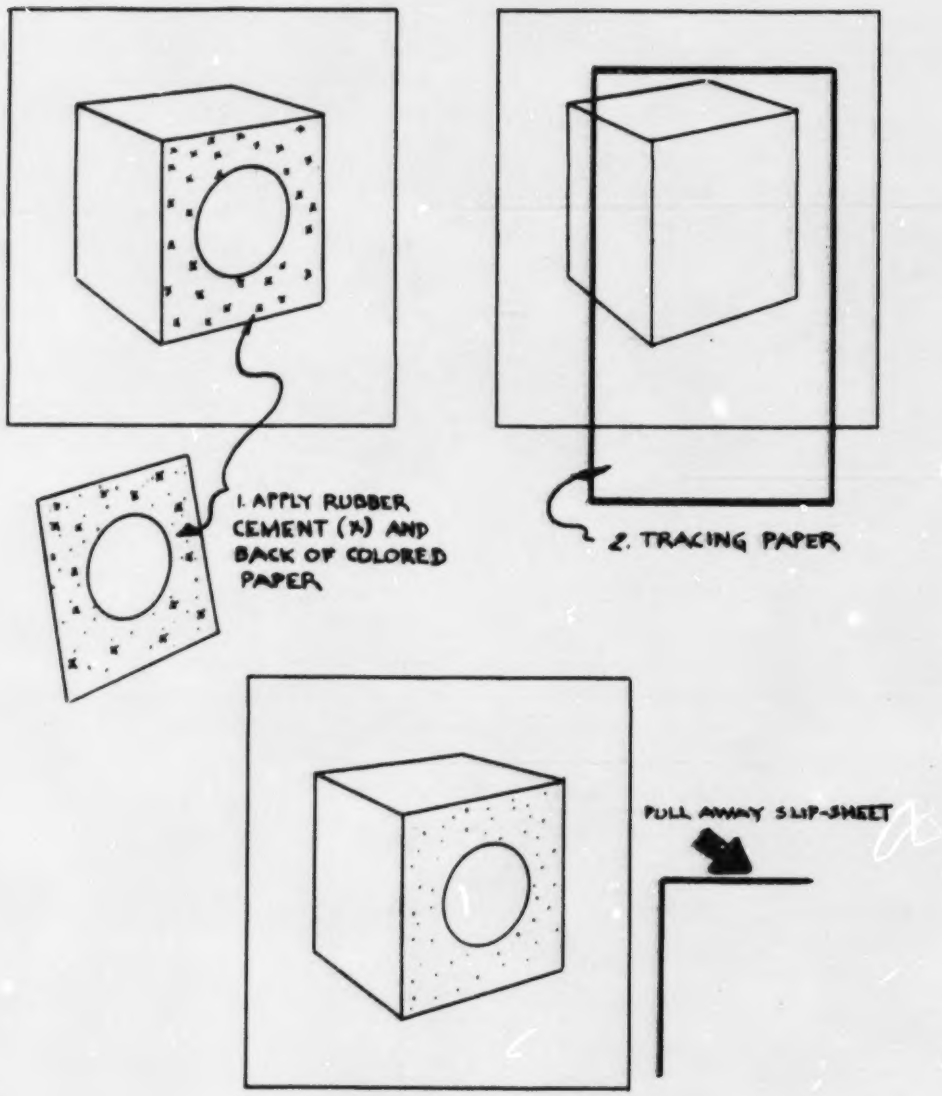


Fig. 5.37

The colored paper, slip-sheet technique is as follows:

Step 1. Apply rubber cement to back of the colored paper and to the space where it will be placed.

Step 2. When dry, place a clean piece of tracing paper over the rubber cement.

Step 3. Lay colored paper in the exact position desired and pull the slip-sheet out. The two surfaces with rubber cement will adhere instantly.

AIRBRUSH RENDERING

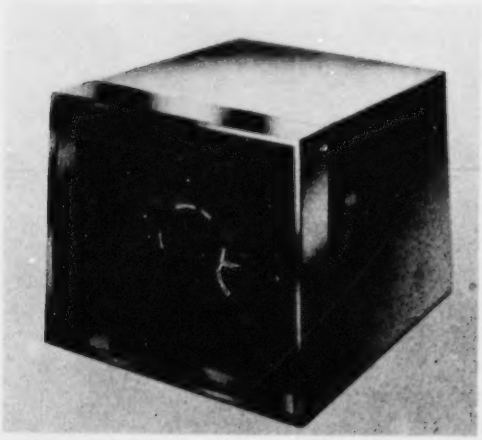


Fig. 5.38

The airbrush rendering is the highest quality and most difficult to accomplish. The airbrush can achieve effects nearly impossible in other mediums. The airbrush may be used just for a highlight on a colored paper overlay or a complete airbrush rendering. Unless the instructor has had experience with an airbrush, and the student has completed basic exercises in its use, it is recommended that an easier medium be used. Students require constant guidance while working with an airbrush. For additional information the following text is available on the subject:

Micklus, C. Samuel, *Airbrush Technology,* New Brunswick N.J.

Vocational-Technical Curriculum Laboratory; Rutgers, The State University, 1977.

MATTING THE RENDERING

After the rendering is completed, it is more effective when carefully matted. The rendering should be covered with a clear acetate, preferably .005 thick, and a clean, well-proportioned, clean-cut matt. The bottom of the matt should be larger than the sides and the top. If the desired matt is 2½" on the sides and the top, the bottom should be 3" or 3½". (Fig. 5.39) Place a protective flap over the finished rendering.

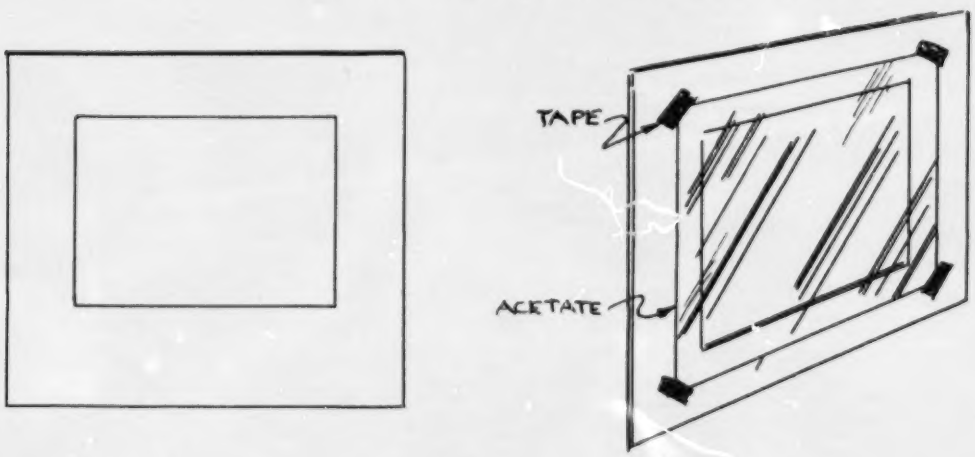


Fig. 5.39

PROTECTIVE FLAP (Fig. 5.40)

Step 1. Lay the illustration board face down on construction paper, keeping bottom and right side flush.

Step 2. Apply rubber cement to areas marked X; let both surfaces dry completely.

Step 3. Fold flap until both cemented areas touch; then press firmly.

Step 4. Trim excess from left side; remove any visible rubber cement by rubbing with your fingers or a rubber cement eraser.

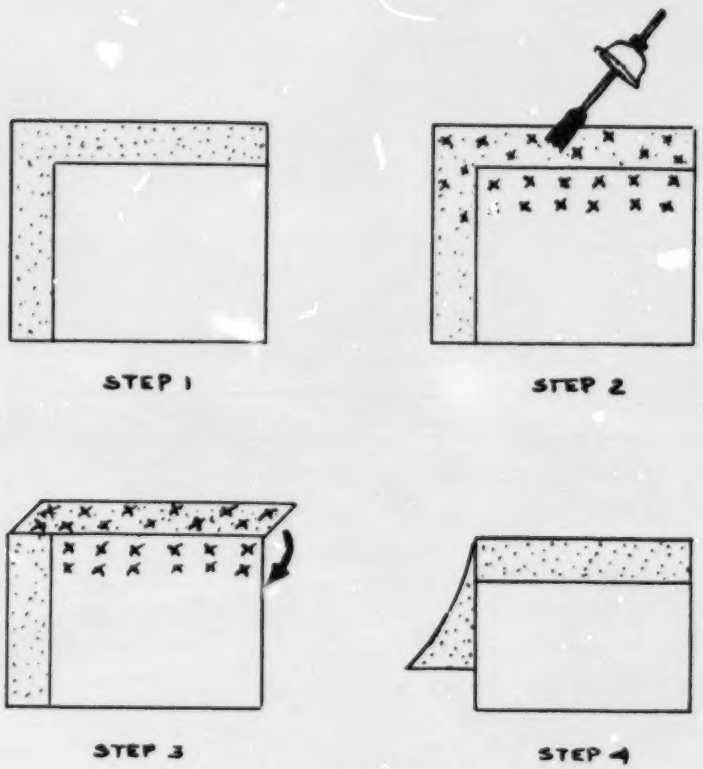


Fig. 5.40

Chapter VI

MODELS

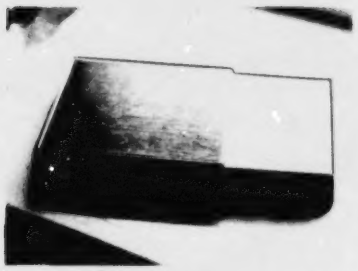


Fig. 6.1

The model is an important step in the design process. The model stage is where many many problems are solved relating to engineering and aesthetics. There are several types of models, and these types may be developed in various industrial education and art facilities. The atmosphere of the technical drawing laboratory is similar to the typical industrial design office. The wood and metal laboratories have similar environments to professional modelmaking facilities. Graphic design problems can be undertaken in the typical graphic arts facility. Graphic design projects may include letterheads, trademarks, exhibits, brochures, packages, record albums, greeting cards and brochures. The typical "comprehensive" layout, or a mockup of the graphic design solution may well be regarded as a model of what the printed matter may be. Depending on the laboratory facilities, modelmaking may be explored more fully in some facilities than others.

PRELIMINARY STUDY MODELS

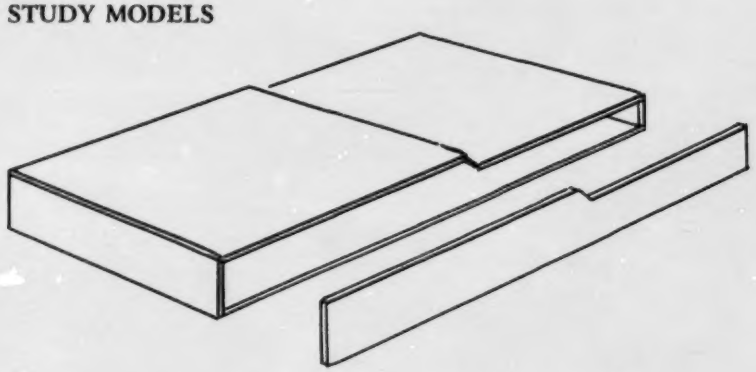


Fig. 6.2

A preliminary study model is a model constructed of clay, plastic, cardboard, or similar inexpensive, easy-to-use material. The purpose of the model is to allow the designer to study the form in three dimensions. This type of model is useful in solving problems rather than trying to visualize complicated shapes on drawings. For the industrial education student, making a preliminary model is usually easier than drawing. In addition to being used to help solve visual problems, models are of great value in discussing production practicability. This model is also used for solving problems such as fits and clearances.

Fig. 6.3

The best type of clay used in constructing a preliminary study model is a non-drying type such as plastilene. Plastilene is a good material to use because it stores well, is easily worked, retains its shape after curing, can be scraped off or added to easily, and can be softened for re-working by heating it. Although not recommended, clay models may be painted, shellacked, and painted again in alternate layers. Several coats are necessary so that the oils in the clay do not bleed through the finish.

Templates may be used to achieve various forms. These may be cut from sheet metal. Plastilene can be made quite large. Automobile manufacturers construct full-size automobile models with wood and this type of clay. The contours for the finished automobile are often taken directly from the model.

APPEARANCE-EVALUATION MODEL

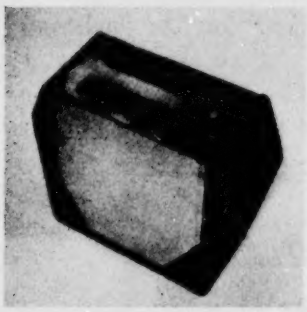


Fig. 6.4

An appearance-evaluation model shows the final design solution in three dimensions exactly as the product will appear when produced. Whenever possible the model should be made full size. Appearance models are sometimes used for market research, for trade shows, and for packaging and engineering studies. Models can be used to calculate dimensions for the finished product. Some models are made as working prototypes; others are not.

Prior to the building of the model, the dimensions should be determined on paper in the form of typical mechanical drawings. These drawings should be as complete as possible. However, they are for the designer or student's own use and need not be as near or complete as a finished working drawing.

Consideration should be given to the type of model to be built and the purpose it will serve. A student in a wood, metal, or manufacturing laboratory may be developing a product which would be something he or she may use. If this is the case, the model may be a working prototype which is an exact working representation of the finished product. In technical drawing, industrial design, or research and development class, the model may be an appearance-evaluation model which would not require it to be a working model.

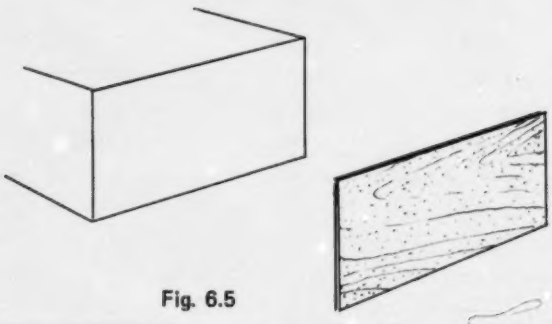


Fig. 6.5

Substituting an imitation material such as wood grain paper etc., does not violate the design principle of *INTEGRITY IN THE USE OF MATERIALS*. The principle would be violated if the finished product were to utilize an imitation material, but is quite acceptable on the model.

Just about any type of material that can be worked may be used. However, some materials lend themselves better under certain working conditions. Balsa wood is a good material used for model making because it is easily fabricated, comes in a wide variety of sizes, and is cut to precision dimensions. Other materials such as plastics, plaster, and various metals can be used in constructing professional looking models.

The finishing of the model is an important step. Attention should be given to every detail, making them as perfect as possible. When finishing wood or cardboard to look like a plastic or a painted metal finish, the wood or cardboard should be given a coat of sealer. When this is thoroughly dry, spray two or three light coats of primer and sand until smooth. Spackling compound is recommended for small imperfections. Repeat the application of primer and sanding until all imperfections are filled. The final coat of primer should be rubbed with a paper towel, then a finished coat of paint applied. The finished color should then be applied by spraying several light coats of paint rather than one or two heavy coats. The heavy coats have a tendency to run, thereby spoiling the finish.

MODEL MAKING TIPS

Fig. 6.6

Fig. 6.6 Spackling paste is good for repairing imperfections. Use a pallet knife and sand smooth when dry.

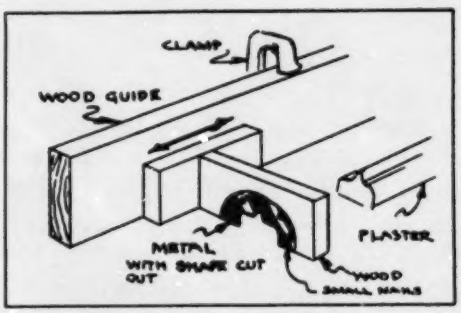


Fig. 6.7

Fig. 6.7 A template cut from metal and attached to a wood support can be made to run plaster shapes to represent extrusions.

Fig. 6.8

Fig. 6.8 Chrome and gold tapes may be used over balsa wood strips to simulate finishes.

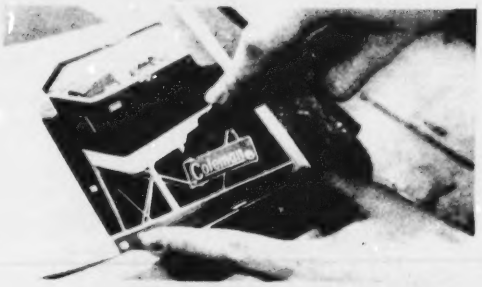


Fig. 6.9

Fig. 6.9 Trademarks may be hand-lettered or cut out of advertisements to make nameplates.

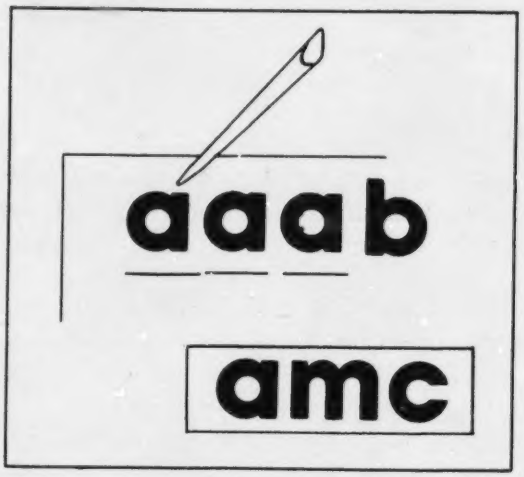


Fig. 6.10 Transfer letters can be very effective on models.

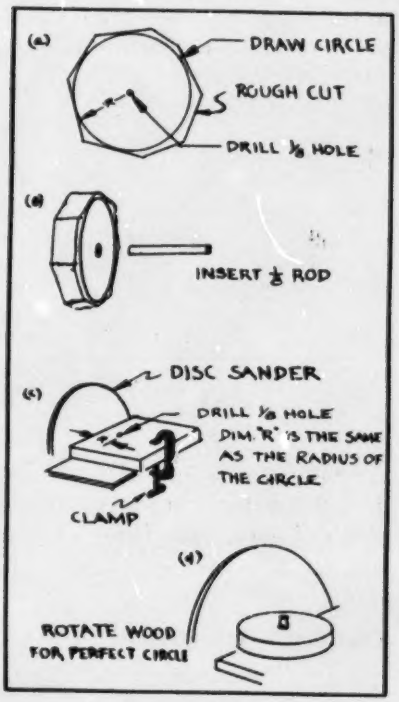


Fig. 6.11 Cutting cirles in wood can be made for wheels, disc, etc. When drilling the 1/8" hole in the wood (a), the hole need not be drilled completely through. In such a case, use a shorter rod for a pivot.

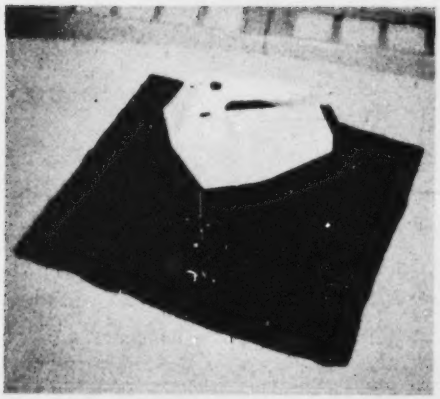


Fig. 6.12 The student can incorporate some existing manufactured parts in the model only if it conforms exactly to the design. The product should not necessarily be designed around existing parts.

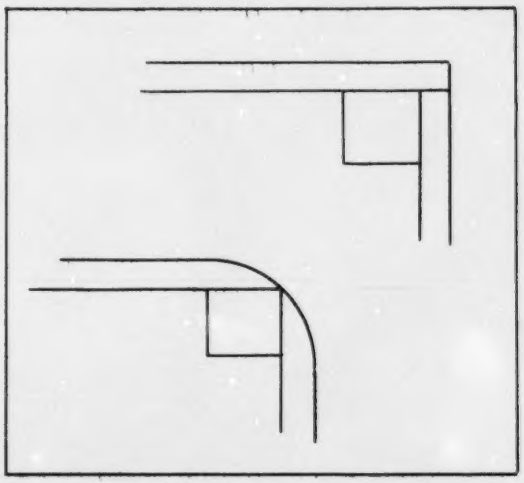


Fig. 6.13 When making a radius on a corner, place an additional piece for support and working area. Avoid cracks and paper thin areas when possible.

Fig. 6.14

Automotive touch-up colors offer excellent color selection at relatively little cost. The small, spray cans eliminate the need for a spray booth or finishing room. (Fig. 6.13)

The finished model may also serve as the final blueprint for the finished product. This occurs often in industry and eliminates the need for the working drawing or contour drawing phase of product development.

The finished model is often the terminating point (except for the presentation discussed in Chapter VII) for the industrial designer's work. The instructor can make the decision as to the extent to which the students will be involved with the design process. Often the designers continue through the contour drawing stage and occasionally through the working drawing stage.

CONTOUR DRAWINGS

Contour drawings are those which convey the contour or the precise exterior dimensions of the finished product. They are not working drawings, but they are used as an aid in the making of detailed drawings. The contour drawings are complete, dimensioned drawings relating to the appearance of the product.

Usually, industrial designers do not engineer the products. The client may have an engineering department which makes decisions such as the gage of sheet metal, mold draft, thickness of sections, and similar problems. The working drawings for production are often drawn by the client's staff. The engineering problems which affect the appearance of the products are worked out by the engineers and the designers.

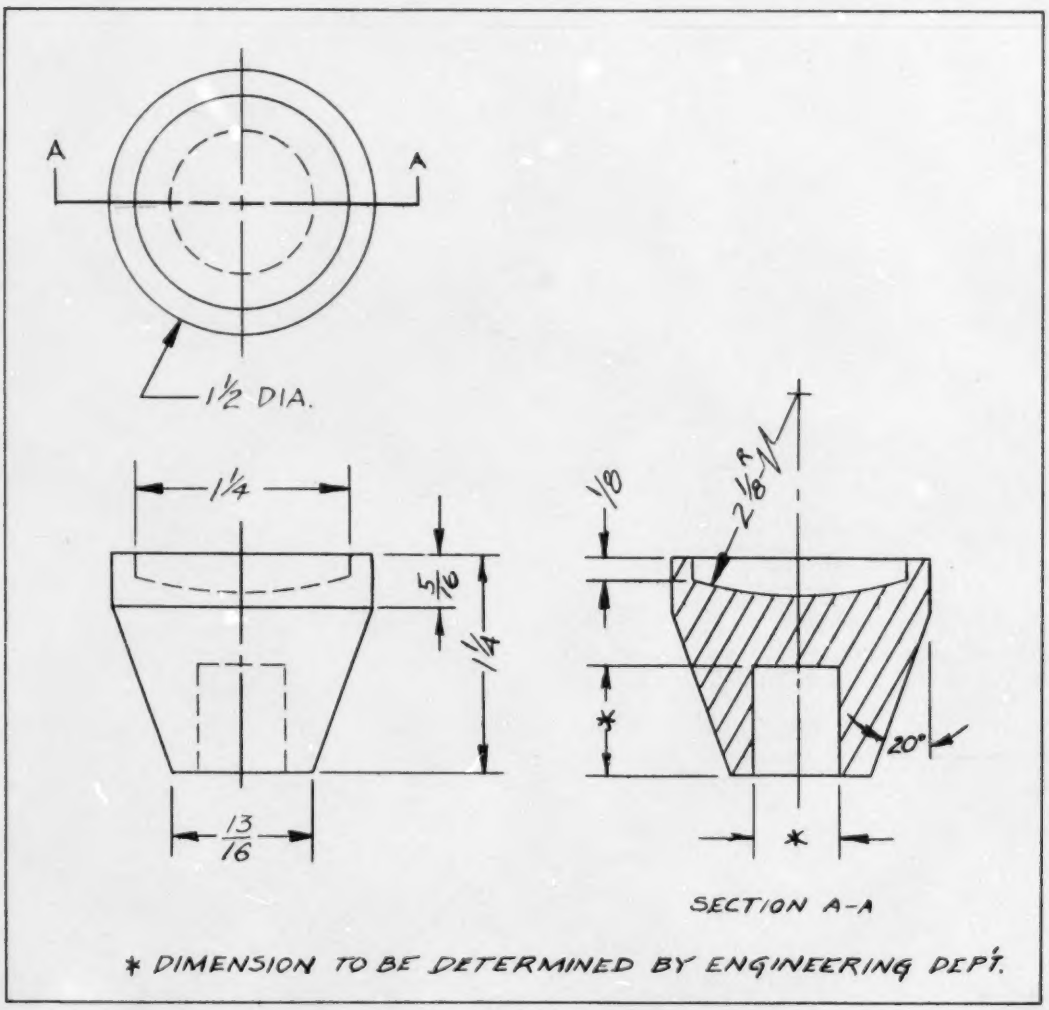


Fig. 6.15

Contour drawings supplied by the designer should follow standard drafting practice and be checked thoroughly for completeness. If the working drawings are prepared by the client, they should be submitted to the designer for approval to insure the visual aspects of the product are retained.

WORKING DRAWING

The designer, or student with the aid of the instructor, will determine the construction of the product and prepare detailed drawings as the individual course requires. The drawings give the information necessary to make the product. Any number of technical drawing texts may be referred to for the preparation of the working drawing.

Chapter VII

PRESENTATIONS

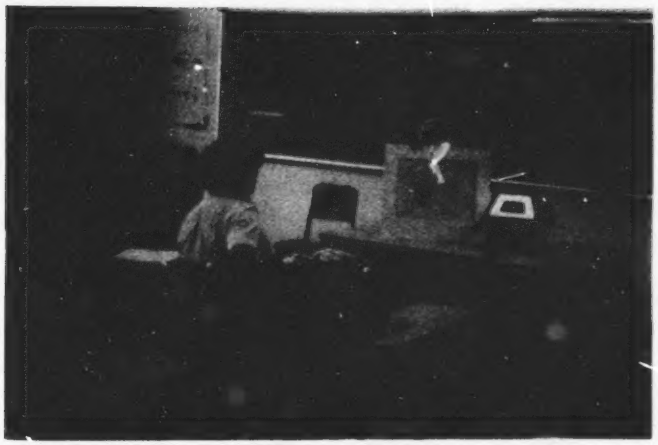


Fig. 7.1

It is an art to communicate meaningful information. The designer must be able to convey his or her creativity to colleagues involved in the specific design problem and ultimately to the client during the various phases of product development. The designer uses several methods to present design solutions at sequential levels of the design process. These aids include the visuals of sketches, renderings, models, and drawings which all terminate with some type of presentation. These visuals assist the designer to communicate the design's progress in its development and to understand what the designer has created. Visual representations seldom can tell the entire story unaccompanied by a verbal explanation by the designer. Therefore, the designer must always accompany the work and not merely send the visuals unexplained, which could easily lead to a misinterpretation.

The presentation is an important part of the design process; it should be well prepared in advance of entering the conference room. Presentations are usually made to top management personnel. Arranging these meetings requires a great deal of coordination from the client to involve the necessary people. It is imperative that the designer's work be completed on time and the designer be punctual for the meeting. If the meeting is to take place in the conference room of the client, the designer should give consideration to the display of the materials. If some type of special equipment is desirable, such as an overhead projector, be sure the client has one readily available or make provisions to bring one.

Prior to the explanation of the sketches, the designer may take a moment to review the problem and the limitations imposed at the outset of the project. This is a good way to lead into the showing of the preliminary sketches. It may also serve as information for some individuals within the company who aren't familiar with some of the limitations. An example may be the presence of an advertising executive who may be unaware of certain engineering restrictions to which the design must conform. The designer should describe the approach as thoroughly as possible. To let the client probe for answers is a poor way of presenting the solution. The designer must ask crucial questions prior to the presentation in order to present what he or she feels is the best direction to establish, and to anticipate questions for defending the design.

During the brainstorming and sketching phases, many ideas will be considered. The designer should use judgement in incorporating those ideas which have the most merit, and work these ideas into several solutions. The designer is retained for ideas and advice, therefore she/he should select from a feeling of what answers the problem best and present it. If the client is confronted with too many sketches, she/he is likely to become confused. Three to six sketches are usually presented at this time.

Fig. 7.2

During the presentation the designer should exemplify poise, taste, and confidence. The designer must have control of the situation and thoroughly cover the design solutions. If one merely spreads a group of sketches on a table with no logical approach to the presentation, it shows a lack of finesse and may give a feeling of superficial surface treatment, or of merely choosing the best looking unit. If this is the objective of the meeting, it may be valid. However, if the objective is to seek a logical, systematic approach to solving the problem, it should be orderly, thorough, and concise.

After a sketch has been shown and discussed, the designer should move on to the next sketch. Do not present one sketch to one person and another sketch to the next person. The designer should have the individual attention of everyone, and several circulating sketches will surely be distracting to the central discussion.

After each sketch has been explained, a short discussion or question period is in order. The designer should try to anticipate and answer questions before they are asked. Another approach is to explain all the sketches, display them, and then open the meeting for questions and discussion. Different sketches often possess desirable features which may be revised into a composite that is superior to any of the originals. This first presentation is similar to a brainstorming session because new ideas will probably emerge. The company's most important consideration is results. If the designer has made some preliminary mechanical drawings prior to the sketching, these drawings may be shown to help the designer communicate ideas to the client.

The rendering presentation differs from the sketching presentation in several ways. One difference is that only one rendering is presented. There may be some subordinate art work explaining certain aspects of the design. However, by this time basic decisions have been made and the direction of the design has been determined. The rendering may graphically represent the final appearance of the product. Materials, construction, form, and basic dimensions have tentively been decided. However, flexibility for revision is possible, if necessary.

The rendering should be executed with precision and handsomely matted. The designer may allow a few minutes for the client and the client's personnel to consider the design. Then, the designer reinforces the drawing with a verbal description of what was done and why. It is to the designer's advantage to have preliminary sketches and drawings readily accessible. Occasionally, a question may arise which can be answered better with the aid of something done previously in the product's development.

Fig. 7.3

The presentation of the appearance-evaluation model is the climax of the industrial designer's endeavor. The designer offering the presentation should closely observe the audience. When new faces appear, they should briefly be brought up-to-date on the development of the product prior to showing the model. The model should be an exact replica of what the finished product will look like including color, materials, form, and construction details. If special lighting, background material, or a special effect will enhance the model, it should be included in the presentation.

As mentioned in the preceding presentations, it is to the designer's interest to have in his or her immediate possession the material shown at preliminary meetings. During one presentation of an appearance-evaluation model, the design was finalized when one person questioned the combination of aluminum and natural walnut on the model. The discussion of material combinations became quite involved. Finally, the censensus of opinion was that a brass-walnut combination should be investigated. At this point the designer produced the preliminary watercolor sketch showing the brass and walnut combination as the original recommendation. The group could see the two schemes, compare them, and make the decision without delay.

Classroom presentations lend themselves to a role playing situation. One or several students can present design solutions playing the role of the designer. Meantime, other students can play various roles such as different corporate executives of the company which is retaining the designer. Students representing the corporation can ask questions, make comments including suggestions, and make criticisms. Presentations can follow each major phase of the products development.

In summary, the good designer must be able to sell his or her design. Mastering the art of communicating your ideas is as important as developing the design. Practice all phases of industrial design; your future career may depend on it.

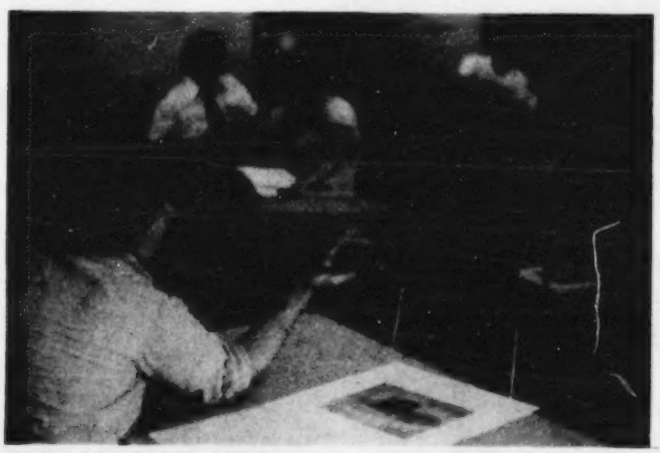


Fig. 7.4